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Arthropod Species Diversity, Composition and Trophic Structure at the Soil Level Biotope of Three Northeastern Illinois Prairie Remnants, with Botanical Characterization for Each Site

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ARTHROPOD SPECIES DIVERSITY, COMPOSITION AND TROPHIC STRUCTURE AT THE SOIL LEVEL BIOTOPE OF THREE NORTHEASTERN ILLINOIS PRAIRIE REMNANTS, WITH BOTANICAL CHARACTERIZATION FOR EACH SITE

by

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INTRODUCTION

Illinois was once covered with 8.5 millon hectares of prairie grassland, which encompassed over 60 percent of the state. This "prairie peninsula" was formed over 8,000 years ago when the warming climate resulted in the final melting of glacial ice in northeast Canada causing an alteration of wind patterns over North America. These altered wind patterns extended the Rocky Mountain rain shadow eastward, thereby producing a drier climate over central North America. Deciduous forest gave way to drought-tolerant herbs and grasses as rains became less frequent and the prairie grassland was established (King 1981).

The grasslands of the North American plains are classified into three major divisions: the shortgrass prairie, the mixed-grass prairie and the tallgrass prairie. Kuchler (1964) describes three subsets of the tallgrass prairie climax community; the _Agropyron-Andropogon-Stipa_ type, the _Andropogon-Calamovilfa-Stipa_ type, and the _Andropogon-Panicum-Sorghastrum_ type. The prairie remnants of Illinois can be classified as the _Andropogon-Panicum-Sorghastrum_ type which is indicative of the True Prairie (Kuchler 1964). The True Prairie is the most typical and maximally developed subset of the tallgrass prairie (Clements and Shelford 1939).

Although the botanical nature and distribution of the True Prairie grasslands in Illinois have been well documented (Gleason 1908, 1910; Vestal 1913, 1914, 1931; Sampson 1921; Evers 1955; Kilburn and Ford 1963; Kilburn and Warren 1963; Bland and Kilburn 1966; Anderson 1970; Schwegman 1973, 1983), characterization of the fauna, particularly the invertebrate community, has been neglected. In his study of an arthropod community in an Illinois prairie, Adams (1915) remarked on the lack of scientific investigation being done on this rich invertebrate community. Adams' comment is still true today. The "Prairie State" has seen little investigative research on the invertebrate populations inhabiting its native grasslands. Shackleford (1929) published the only other comprehensive study of the arthropod community in an Illinois True Prairie. He described the composition of the animal community in a True Prairie and observed the seasonal variations within it. In addition, he compared this community to the animal community of a degraded prairie to observe the changes caused by secondary succession. All other studies of Illinois prairie invertebrates have dealt with the taxonomy, life history or distribution of certain arthropod species (Parks et al. 1949,1953; Auerbach 1951; Hamilton 1981; Hamilton and Kuritsky 1981).

Studies of the arthropod community in the True Prairie region have been done in other states. Risser _et al_. (1981) characterized the entire True Prairie region. Their three year survey encompassed both biotic (plant, invertebrate and vertebrate) and abiotic (climate, grazing, fire, nutrients, irrigation and pesticides) interactions of the True Prairie ecosystem and reported on the structure, function and utilization of these grasslands. Their study took place between the years 1970 through 1972 and was part of the International Biological Program (IBP). The work done on the prairie arthropod community included twelve sites from eleven states, however, most of the data was collected primarily from the Osage Prairie. This site is a True Prairie of 14,000 ha located in Osage County, northeastern Oklahoma. Collections were taken from the foliage, soil and subsoil level biotopes using all the typical trapping methods (core samples, pitfall traps, sweep nets, quick traps, free-fall traps, D-vac, Tullgren funnel and extractor and general hand collection). Their study characterized the major taxonomic groups of arthropods by composition and trophic structure.

Evans _et al_. (1969) studied the insect community on a 4.8 ha old field (degraded prairie undergoing secondary succession) in Michigan. Their purpose was to determine the structure and organization of the adult pterygote insect community of the foliage level biotope by characterizing taxonomic composition, trophic structure and seasonal patterns. This study was conducted from 1948 to 1966, but most of the data were taken from 1957-61 and 1964. A variety of trapping methods were employed and included general hand collecting, aerial and sweep nets, malaise flifht trap and pitfall traps. Percent composition of species by order and trophic level, species richness by family, as well as percent similarity were recorded to measure the turnover rate of species in the course of a season.

This thesis is the first comparative study of the invertebrate populations inhabiting Illinois prairie remnants. The object of this study is to characterize the arthropod population of the soil level biotope from three Cook County, Illinois prairie remnants and compare these remnants with respect to composition, dominance, species diversity, and trophic structure. In addition, the effects of prairie remnant size and certain botanical parameters on the arthropod community were evaluated. Murdoch et al. (1975) studied the diversity of Homoptera in three large old fields in Michigan. The purpose was to determine if correlations existed between plant diversity, evenness and number and insect diversity, evenness and number.

The present study is based entirely on samples from the soil level biotope and as a result it does not represent the total prairie arthropod community. However, the information derived from this study is extremely valuable since no baseline data of the arthropod population exists for Illinois prairie remnants. The pitfall trap was selected because this trapping method collects a high percentage of resident prairie arthropods from this biotope. Many investigators have identified the limitations, drawbacks, and problems associated with this trapping technique (Briggs 1961, Mitchell 1963, Greenslade 1964, Hayes 1970, Ahearn 1971, Turnbull 1973, Luff 1975, Hagvar *et al*. 1978, Southwood 1978). However, for the purpose of population studies, the pitfall trap can be a valuable and accurate collecting method (Uetz and Unzicker 1976, Thomas and Sleeper 1977, Adis 1979). Diversity indices representing the true arthropod community can be determined from pitfall trapped data, provided that the populations inhabit similar areas and are collected within the same sampling period (Kowalski 1976). In addition, pitfall trapped data will give closer estimates of species richness, diversity, and relative abundance of the soil level biotope population than any other trapping method available (Uetz and Unzicker 1976).

The data from this study will provide an additional means of assessing the quality and stability of the Illinois True Prairie. Currently, only botanical characteristics and soil analysis are used to assess prairie remnant quality. The information gained from this study is meant to provide further insights into the relationship of arthropod diversity to remnant size and quality, prairie plant diversity, and management practice. The knowledge and information gained from this thesis could play an importantrole in future preservation and restoration of Illinois prairie remnants.

DISCRIPTION OF STUDY AREAS

James Woodworth Prairie (JWP): JWP is owned and managed by the University of Illinois at Chicago. This preserve is located in Maine township on the east side of Milwaukee Avenue, one half mile north of the Golf Road and Milwaukee Avenue intersection. The small prairie remnant is completely surrounded by urban development. Houses border its north side and commercial businesses on its south side. Greenwood Avenue and Milwaukee Avenue abut the property on its east and west sides respectively. JWP is completely fenced and permanently staked out into ten meter square quadrants. This prairie remnant is regularly cleared of weeds and invading trees and shrubs. JWP is under an annually scheduled burning program that started in 1972. In recent years, the southern and northern halves have been burned alternately (Rouffa, personal communication). This parcel of land was known as the Peacock Prairie until 1972. Testimony from the descendants of the Long family who are local residents (Paintin 1929), aerial photographs and diversity of the flora (Betz et al. 1969) indicate that James Woodworth Prairie Preserve has never been plowed or systematically grazed.

This remnant is of approximately 2.14 hectares and composed primarily of mesic black soil (Table 1). In 1972, an interpretive center and parking lot was built on 0.20 ha of the land (Rouffa, unpublished). Three grades of quality are present in this remnant of which 70 percent is of A quality (Table 2). The pristine nature of JWP is also indicated by its very diverse flora, which has been well documented (Paintin 1929, Betz and Cole 1969, Apfelbaum and Rouffa 1981). Betz and Cole (1969) commented that the great plant variety, lack of uniformity of the vegetative cover and the lack of dominance of any one species indicated conditions of high quality and prolonged virginity. In 1983, 97 plant species native to the tallgrass prairie biome were believed to be in this remnant (Table 2). The preserve contains nine of the eleven dominant prairie grasses: big bluestem grass, little bluestem grass, blue joint grass, Canada wild rye, June grass, switch grass, prairie cord grass, prairie dropseed and Indian grass. Of the sixteen prairie indicator forbs this preserve contains fourteen: leadplant, heath aster, cream wild indigo, stiff tickseed, rattlesnake master, prairie gentian, prairie alum root, prairie lily, hoary puccoon, white prairie clover, purple prairie clover, prairie cinquefoil, prairie violet and golden alexanders. The NARI of this prairie remnant is 72.

Miami Woods Prairie (MWP): This prairie remnant is part of the Miami Woods Forest Preserve and is owned by the Cook County Forest Preserve District (CCFPD). MWP lies within Niles township and is located east of Caldwell

Avenue and north of Oakton Street. The prairie remnant is boardered by forested areas on the north and south, residences on the west, and the North Branch of the Chicago River on the east. Its management is handled by the North Branch Prairie Project (NBPP) which is supported by the Chicago Audubon Society, Illinois Chapter of the Nature Conservancy and the Chicago Group of the Sierra Club. MWP is one of seven prairie remnants which the NBPP began to manage in 1977. During the past five years various prairie plant seeds, corymbs, rootlets and seedlings have been introduced to this remnant. Many plant species are gradually increasing due to the restoration efforts and large amounts of brush that have been cleared. An annual random patch burning program began in 1983 (Packard, personal communication).

MWP is predominently a mesic black soil prairie of approximately 6.07 hectares (Table 1). Ninety percent of this prairie is classified as grade C and is considered to be a low quality disturbed remnant (Table 2). In 1983, 83 prairie plant species inhabiting this remnant were documented (Packard, unpublished). However, eighteen of these prairie plants have been recently introduced and have not been included in the remnant's botanical assestment. This prairie remnant exhibits two distinct floral habitats. The larger northern half of this prairie remnant was

Table 1. Soil Characteristics of the Three Prairie Remnants

	JWP	MWP	STP
Soil Moisture Content			
Mesic	79%	90%	72%
Wet-mesic	21%	10%	28%
Soil Composition			
Black Soil	100%	100%	28%
Sand	-	-	72%

Table 2. Prairie Quality and Botanical Characteristics of the Three Prairie Remnants

	JWP	MWP	STP
Quality Grades			
Grade A	70%	-	-
Grade B	15%	10%	40%
Grade C	15%	90%	60%
Plant Species Composition			
Native prairie plants	97	65	88
Dominant prairie grasses	9	4	9
Prairie indicator forbs	14	4	7
Native Area Ratings Index (NARI)	72	51	61

acquired by the CCFPD in 1921 by two land purchases. This half is characterized by a large variety of prairie plants and shows good diversity. However, large stands of common mountain mint (Pycnanthemum virginianum (L.)) dominate the north central portion of this area. The southern portion of this prairie remnant was purchased by the CCFPD in 1946 and some evidence indicates that this parcel of land was farmed (Packard, unpublished). Much of this region is dominated by various non-native shrubs and weeds such as white sweet clover (Melilotus alba Desr.), bluegrass (Poa sp.), poverty oat grass (Danthonia spicata (L.)), rough dropseed (Sporobolus asper (Michx.)) and giant ragweed (Ambrosia trifida L.) and can be considered an old field (Packard, personal communication). Four dominant prairie grasses are present in this prairie remnant; big bluestem grass, switch grass, prairie cord grass and Indian grass. Four prairie indicator forbs are found on this remnant: heath aster, cream wild indigo, prairie alum root and golden alexanders. The NARI of this prairie remnant is 51.

Stein Tract Prairie (STP): This remnant is owned primarily by the city of Markham and lies adjacent to the 50.99 hectare fenced Gensburg-Markham Prairie Preserve. The remnant is located in Bremen township north of 155th Street, between Afton Drive and the Tri-State Tollway. The tract is boardered by residences on the west and north, I-294 on the east, and the prairie preserve on the south.

The Stein tract is not currently under management. The Nature Conservancy is seeking to purchase this parcel of land and incorporate it into the Gensburg-Markham Prairie Preserve.

This remnant is approximately 25.90 hectares and is predominantly a mesic mixed sand and black soil prairie (Table 1). However, the southern 7.28 ha of STP is considered a wet-mesic black soil prairie. Sixty percent of this prairie is of grade C quality while 40 percent is of grade B (Table 2). Survey records of this area in presettlement times indicate that the remnant was a mixture of prairie and prairie marsh. STP remained essentially undisturbed until the late 1940's when this land was platted for a housing subdivision. Aerial photographs taken in 1949 and 1961 indicate that the northern and western sections of this remnant suffered the most damage (Betz, unpublished). In these disturbed areas weedy communities are still present with the dominant weeds being white sweet clover, Queen Ann's Lace (*Daucus carota* L.) and daisy fleabanes (*Erigeron strigosus* Muhl.). However, the prairie is showing signs of recovery and prairie grasses have been reclaiming these disturbed areas (Betz, unpublished). The flora of the Stein tract prairie was updated in 1982 (Betz, unpublished) and 88 prairie plants were recorded (Table 2). Though a visual survey of this remnant would suggest that it is not as botanically diverse as the Gensburg-Markham Prairie Preserve, nine of the eleven dominant prairie grasses inhabit this tract: big bluestem grass, little bluestem grass, blue joint grass, Canada wild rye, prairie sedge, switch grass, Indian grass, prairie cord grass and prairie dropseed. Seven prairie forb indicators can also be found in this remnant: heath aster, cream wild indigo, rattlesnake master, prairie alum root, purple prairie clover, prairie cinquefoil and golden alexanders. The NARI of this prairie remnant is 61.

MATERIALS AND METHODS

The three prairie remnants were selected on the basis of several factors that are more or less related to arthropod diversity. These factors were size, soil and prairie quality. The size of each remnant was measured in hectares determined from the 1982 Illinois Natural Area Inventory Survey (INAIS) or by management records. The soil from the prairie sites was characterized by moisture (wet, mesic and dry) and composition (sand, black and clay). The quality of the prairie remnants was assessed by several factors. These characteristics were INAIS quality grades, the number of prairie plant species, the population densities of dominant prairie grasses, the presence of prairie indicator forbs and NARI values (Swink and Wilhelm 1979). INAIS quality grades are based on the presence and extent of disturbed areas, i.e. areas denoted by the presence of weeds and non-native shrubs, and from historical records or other documentation. Three categories of grade were used. Grade A quality is indicative of pristine, undisturbed area; an area of native condition. Grade B quality is assigned to a native environment which exhibits some signs of disturbance. Grade C quality denotes areas of extreme disturbance indicative of grazing and/or cultivating practices. Botanical data were derived from flora lists provided by the management of each prairie remnant. Native prairie plant species were identified from these lists by Floyd A. Swink of the Morton Arboretum. The dominant prairie grasses and indicator forbs of these three prairie remnats were taken Schwegman (1983). Schwegman defines and indicates eleven dominant prairie grasses and sixteen indicator forbs inhabiting Illinois prairie remnants (Table 1). Dominant prairie grasses are those plants which occupy the most space in a prairie because of their distribution and numbers. Prairie indicator forbs are those plants that are restricted to the prairie community and will decline or disappear with disturbances such as heavy grazing or farming. These plants are useful in recognizing a true undisturbed prairie remnant. The Native Area Rating Index (NARI), developed by Swink et al. (1979), was used to determine the native condition of each remnant. The NARI value for each remnant was calculated by using only plants native to the prairie biome that were present on the remnant for five years or more. This eliminates recently introduced plant species which would have little if any affect on this study since arthropod relationships associated with these introductions would not yet have been established. NARI values greater than 40 indicate an area that possesses sufficient native character to be of considerable importance, while values greater than 50 denote very rare areas of extremely high quality that

Table 3. Dominant Grasses and Indicator Forbs of Illinois True Prairies

Dominant Prairie Grasses	
Andropogon gerardii Vitman	Big bluestem grass
Andropogon scoparius Michx.	Little bluestem grass
Bouteloua curtipendula (Michx.)	Side-oats grama
Calamagrostis canadensis (Michx.)	Blue joint grass
Carex bicknellii Britt	Prairie sedge
Elymus canadensis L.	Canada wild rye
Koeleria cristata (L.)	June grass
Panicum virgatum L.	Switch grass
Sorgastrum nutans (L.)	Indian grass
Spartina pectinata Link	Prairie cord grass
Sporobolus heterolepis Gray	Prairie dropseed
Prairie Indicator Forbs	
Amorpha canescens Pursh	Lead plant
Aster ericoides L.	Heath aster
Baptisia leucophaea Nutt.	Cream wild indigo
Coreopsis palmata Nutt.	Prairie coreopsis
Echinacea pallida Nutt.	Purple coneflower
Eryngium yuccifolium Michx.	Rattlesnake master
Gentiana puberulenta Pringle	Prairie gentian
Heuchera richardsonii R. Br.	Prairie alum root
Lilium philadelphicum andinum Nutt.	Prairie lily
Petalostemum candidum (Willd.)	White prairie clover
Petalostemum purpureum (Vent.)	Purple prairie clover
Potentilla arguta Pursh	Prairie cinquefoil
Sisyrinchium campestre Bickn.	Prairie blue-eyed grass
Viola pedatifida G. Don	Prairie violet
Zizia aurea (L.)	Golden alexanders

are of paramount importance (Swink and Wilhelm 1979).

Arthropods from the soil level biotope were sampled by pitfall traps in July of 1983. A ten square meter grid system within an approximate area of 2.00 ha was charted for each study site (Figures 1-3). While the entire JWP remnant, composed of 200 quadrats, was trapped, only the northwestern section of MWP and the southern portion of STP were sampled. Each of these two regions consisted of 198 quadrats and were selected because they exhibited distinct mesic black soil prairie areas and a good prairie plant diversity, although differing in the levels of disturbance. A three part plastic pitfall trap (Morrill 1975) was installed flush to the soil's surface within fifteen randomly preselected quadrants. A killing preserving solution of 50 percent ethanol was placed in the inner cup of each trap. A sampling period of 48 hours was run at each remnant between July 12-17, 1983. Samples were transferred to ten ounce plastic jars containing 70 percent ethanol and labeled with the corresponding quadrat coordinates. All adult arthropods were sorted, identified to family (Borror et al. 1981) and counted to the species level. Some groups were sent to specialists for species identification. Immatures were not included in the comparisons unless they could be associated with their respective adults. All arthropods have been retained in a voucher collection at Loyola University of Chicago, Lake Shore Campus.

Figure 1. Grid Map of JWP with Trap Locations

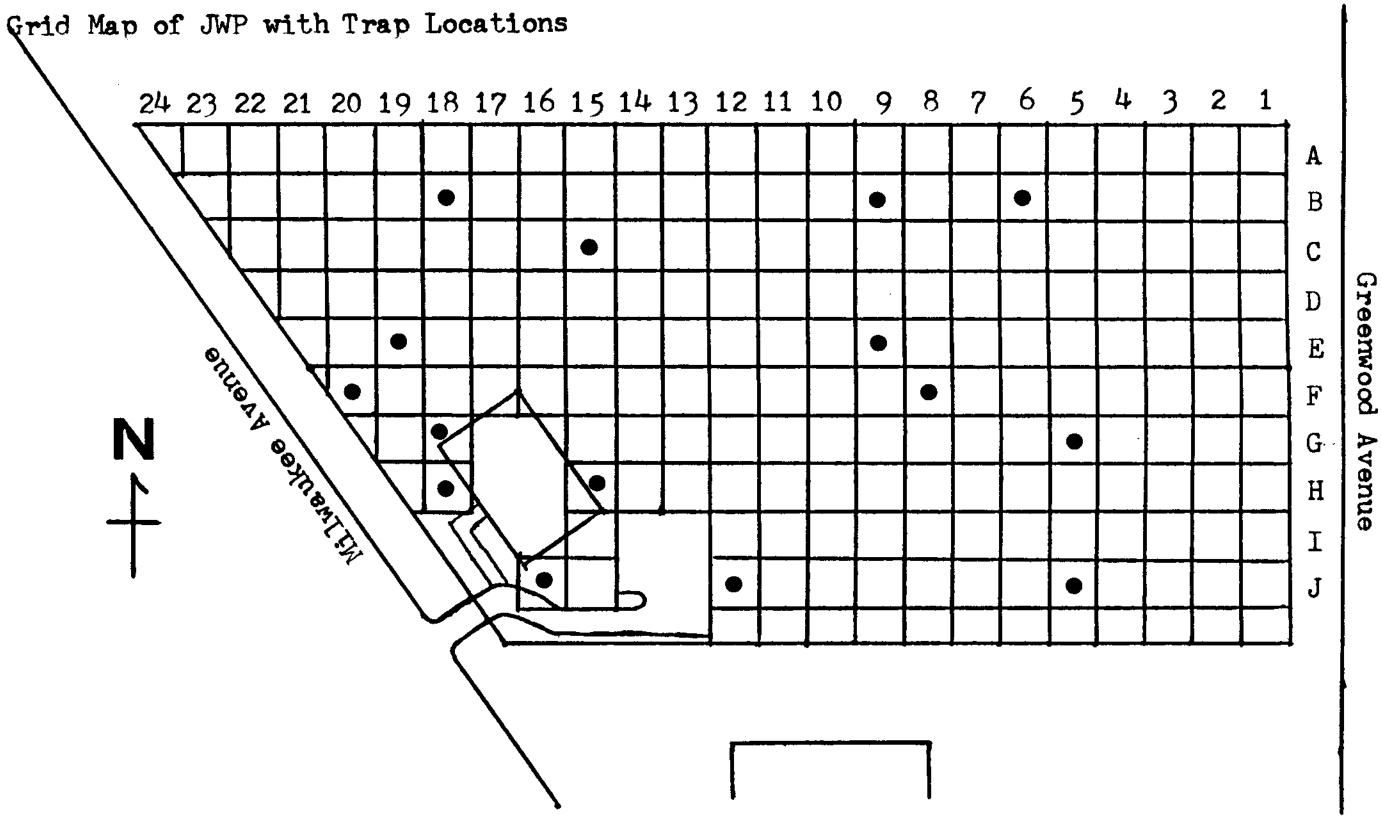


Figure 2. Grid Map of MWP with Trap Locations

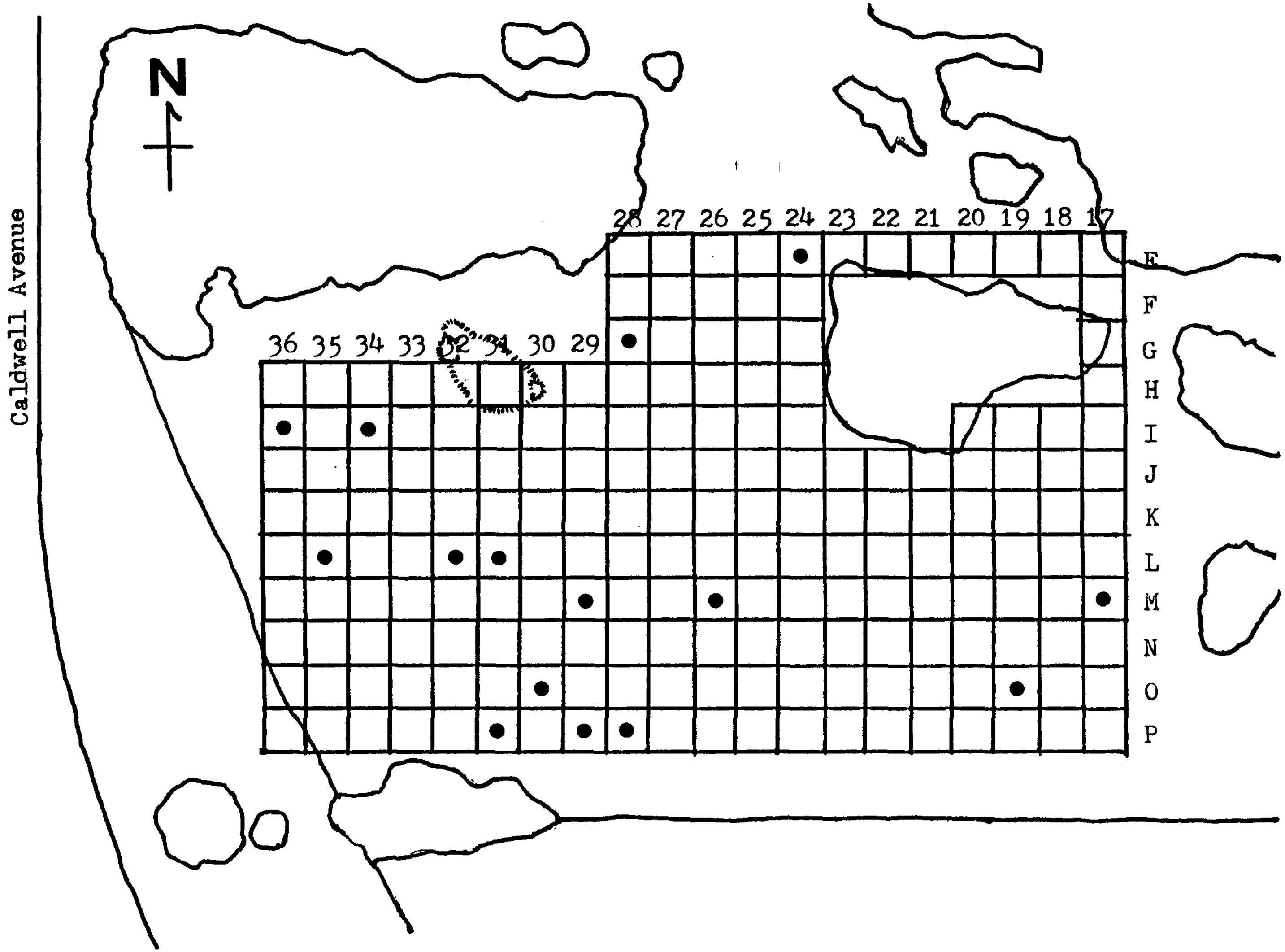
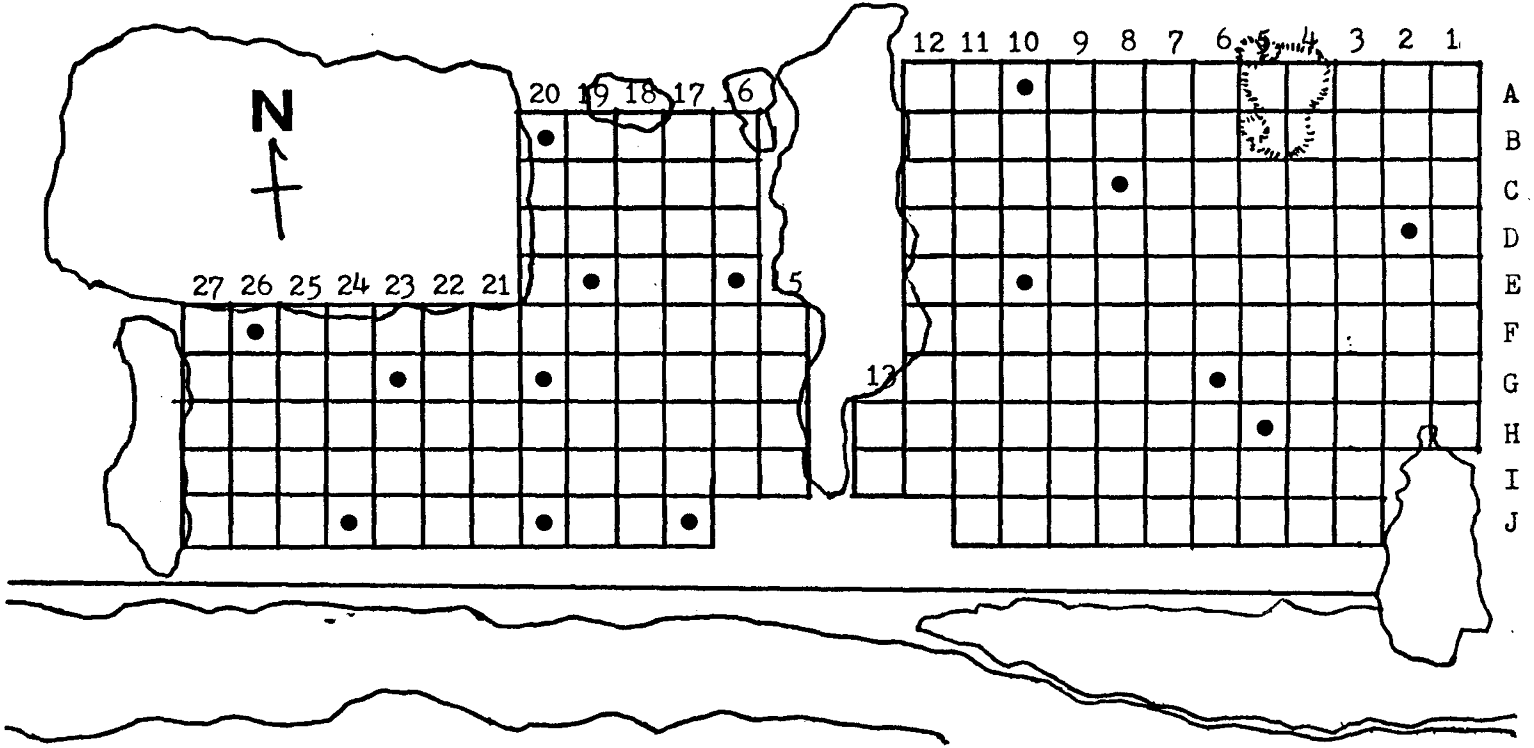


Figure 3. Grid Map of STP with Trap Locations



The soil level biotope arthropod community was characterized by using several diversity parameters: (1) species richness (k), the number of species per sample; (2) individual richness (n), the number of arthropods per sample; (3) Brillouin's diversity index (H), (Zar 1984); (4) Pielou's evenness (J), (Zar 1984). A distinction is made between the numbers of arthropods collected and arthropod richness. The number of arthropods trapped represents a simple tally of all the different species or individuals collected. Arthropod richness implies the number of species or individuals taken per sample, regardless of taxonomic classification. Brillouin's formula was selected because the data were collected in a non-random fashion, all of the arthropods trapped could be identified, and the data could be considered as a self-contained community and not as a sample from a larger population (Pielou 1966a, 1966b). All four of these diversity parameters were calculated for each sample jar using an IBM mainframe computer. A Kruskal-Wallis test was used to test significance of the diversity data. Percent similarity of arthropods at the family, species and individual level, as well as, prairie plant species similarity were calculated using either a modified Sorensen's coefficient of similarity (Southwood 1978) or a modified Curtis' community coefficient (Q), (Southwood 1978), in which two-way comparisons were determined by $Q = [2jN/aN + bN]$ *

100 and three way comparisons were determined by Q = [3jN/ aN + bN + cN] * 100. For the Sorensen equations, jN is the number of families or species found common at each site and aN, bN or cN are respectively the total number of families or species found in each site. For the Curtis equations, jN is the value of the lesser sum of individuals for the species found common to both habitats and aN, bN and cN are respectively the total number of individuals found collected from each site. Coefficient values greater than 50 percent denotes similarity, while values less than 50 percent indicate dissimilarity (Price 1975).

Adult trophic level relationships were determined on a family level basis through relevent literature (Krantz 1978, Borror et al. 1981, Risser et al. 1981, Kethley 1982). Arthropods were classified into five trophic level categories: Herbivores, Carnivores, Omnivores, Detritivores and Parasites. Herbivores are consumers of plant primary biomass and included plant tissue feeders, sap feeders and pollen, nectar and seed feeders. Carnivores are arthropods that catch, kill and consume animals for nutrition. Omnivores are arthropods that consume a variety of both living and dead plant matter and animal tissue for nutrition. Detritivores are consumers of dead organic matter and/or fungi and include scavengers and fungivores. Parasites are arthropods that live in or on a different animal species and obtain nutrients from this host.

RESULTS AND DISCUSSION

JWP and MWP are similar to each other in respect to size and soil type (Table 2). Both are small parcels of land and are predominantly mesic black soil prairies. This is to be expected since both remnants are in close proximity to one another (approximately 3 kilometers). STP, however, is a larger remnant that is primarily a mesic sand prairie. This again is expected, since STP is the only remnant of the three that lies within the Lake Plain of glacial Lake Chicago, an area known for its sandy soil (Schwegman 1973). JWP is the only remnant that has been under prolonged and intensive management. The recent management practices at MWP have not had time for their full effect to be realized and are therefore, not applicable to this specific study. STP has never been under a management program and although it has been burned three or four times in the past thirteen years, these fires were a result of vandalism (Packard and Betz, personal communication). The quality seen in these three remnants is dissimilar (Table 3). JWP is the only remnant that contains grade A quality (70 percent of the total) and can be considered a high quality prairie. MWP and STP are similar in quality, both exhibiting several levels of disturbance. JWP and STP both contain a rich prairie plant diversity. JWP contains the most prairie plants (97), followed by STP (88) and MWP (65). It also contains the highest number of dominant prairie grasses and indicator forbs (23). Distinct levels of prairie quality are, therefore, exhibited in these study sites. JWP is essentially an undisturbed remnant, STP is a moderatly disturbed prairie and MWP is an extremely disturbed remnant. However, NARI values of all three of these remnants indicate that all are of high botanical quality and close to the native condition. It is interesting to note that even though three distinct levels of disturbance are present in these three study sites, the botanical composition is similar (Table 4). Percent similarity indices show that JWP and STP are more similar to each other than either is to MWP. This suggests that these remnants still share a great deal of quality and homology even after a century of separation and disturbance.

The number of orders, families, species and individual arthropods collected from each remnant are indicated in Table 5. The number of orders collected at each site was extremely consistant. Family and species numbers were highest at JWP, followed by STP and MWP. STP contained the highest number of individuals trapped and represented 50 percent of all arthropods collected in this study. The number of families in each order was similar for all three remnants (Table 6). Families representing

Table 4. Plant Similarity Indices

Comparison	Species
Two-way Comparisons	
JWP vs MWP	65.4
JWP vs STP	69.2
MWP vs STP	58.8
Three-way comparison	
JWP vs MWP vs STP	50.4

Table 5. Arthropod Composition Data of the Three Study Sites

Category	JWP	MWP	STP
Number of Orders	15	14	14
Number of Families	82	69	76
Number of Species	211	172	198
Number of Individuals	2,347	2,189	4,573

the four orders Acarina, Araneae, Coleoptera and Hymenoptera were dominant at each prairie site and comprised 66 percent of total at JWP, 65 percent of total at MWP and 59 percent of total at STP (Figure 4).

The number of species found in each order was also very homogeneous for all three prairie sites (Figure 5). The orders Acarina, Araneae, Coleoptera, Collembola and Hymenoptera exhibited the highest number of species of all sixteen orders, each containing at least twenty species (Table 7). Hymenoptera contained the highest number of species at all three remnants with JWP containing 46 species (22 percent of the total), MWP containing 34 species (20 percent of the total) and STP containing 37 species (19 percent of the total). Evans and Murdoch (1969) found similar Hymenopteran numbers in their twelve year study of the pterygote insect community in an old field in Michigan. They collected 578 species of Hymenoptera, which represented 37 percent of all insects taken. However, Risser et al. (1981) found that Coleoptera contained the highest number of species at the Osage prairie in Oklahoma. In this study, Coleoptera was ranked fourth in species dominance at MWP and STP and tied for third with Araneae at JWP. Evans and Murdoch (1969) also found lower numbers of Coleoptera species and attributed this to their rather cryptic and sedentary nature. The prairie contains relatively few areas

Table 6. Number of Arthropod Families/Order

Order	JWP		MWP		STP	
	Total	Rank	Total	Rank	Total	Rank
Acarina	21	(1)	18	(1)	17	(1)
Aranea	10	(4)	7	(4)	8	(5)
Coleoptera	11	(3)	9	(3)	10	(2)
Collembola	4	(7)	3	(7)	4	(7)
Diptera	7	(5)	5	(6)	10	(2)
Hemiptera	1	(10)	1	(10)	2	(10)
Homoptera	5	(6)	7	(4)	7	(6)
Hymenoptera	12	(2)	11	(2)	10	(2)
Isopoda	1	(10)	1	(10)	1	(10)
Lepidoptera	4	(7)	-		-	
Lithobiomorpha	1	(10)	1	(10)	1	(10)
Opiliones	1	(10)	1	(10)	1	(10)
Orthoptera	1	(10)	2	(8)	3	(8)
Polydesmida	-		-		1	(10)
Spirobolida	1	(10)	1	(10)	-	
Thysanoptera	2	(9)	2	(8)	1	(10)

Figure 4. Percent Families of Arthropods

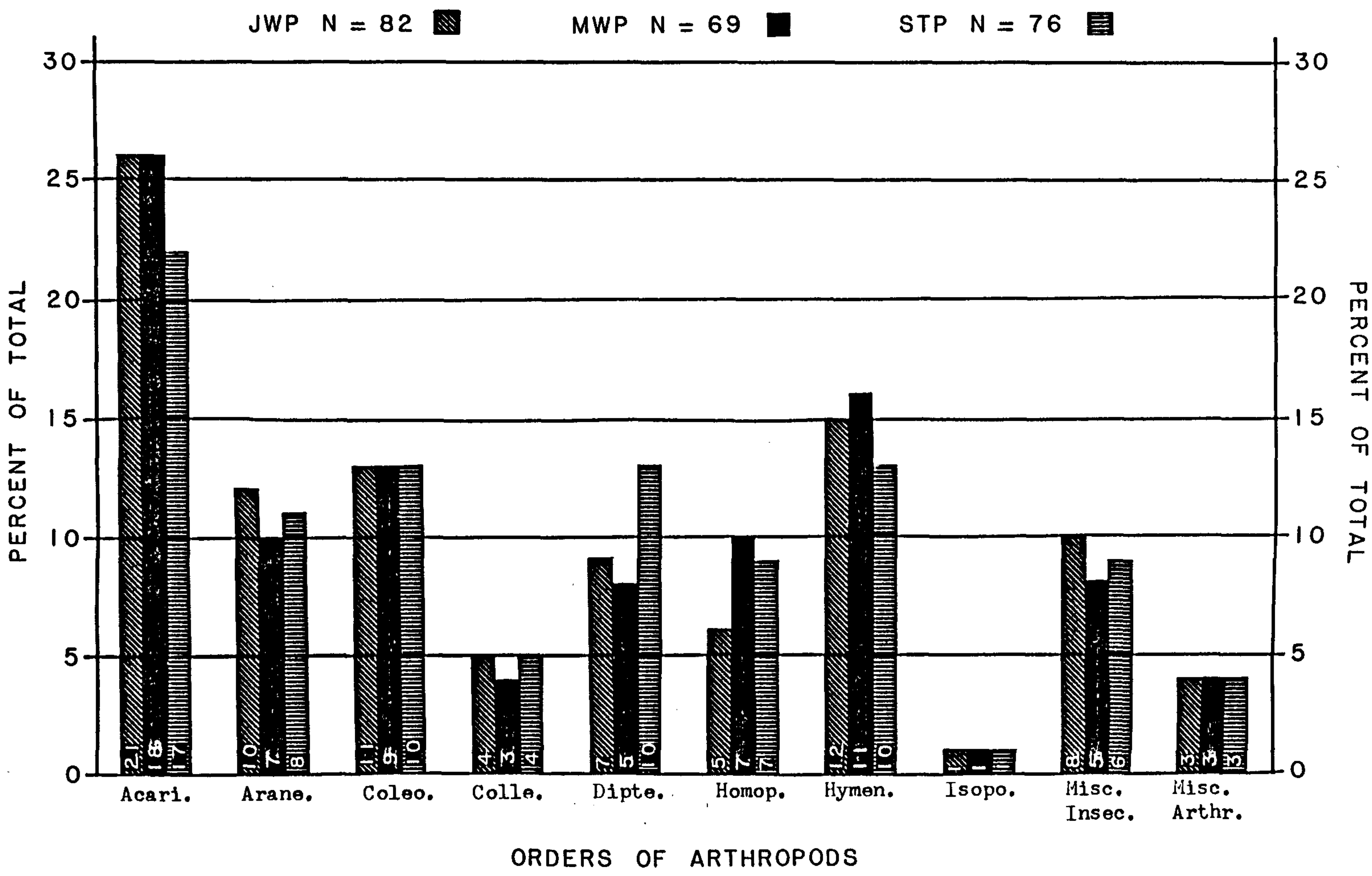


Figure 5. Percent Species of Arthropods

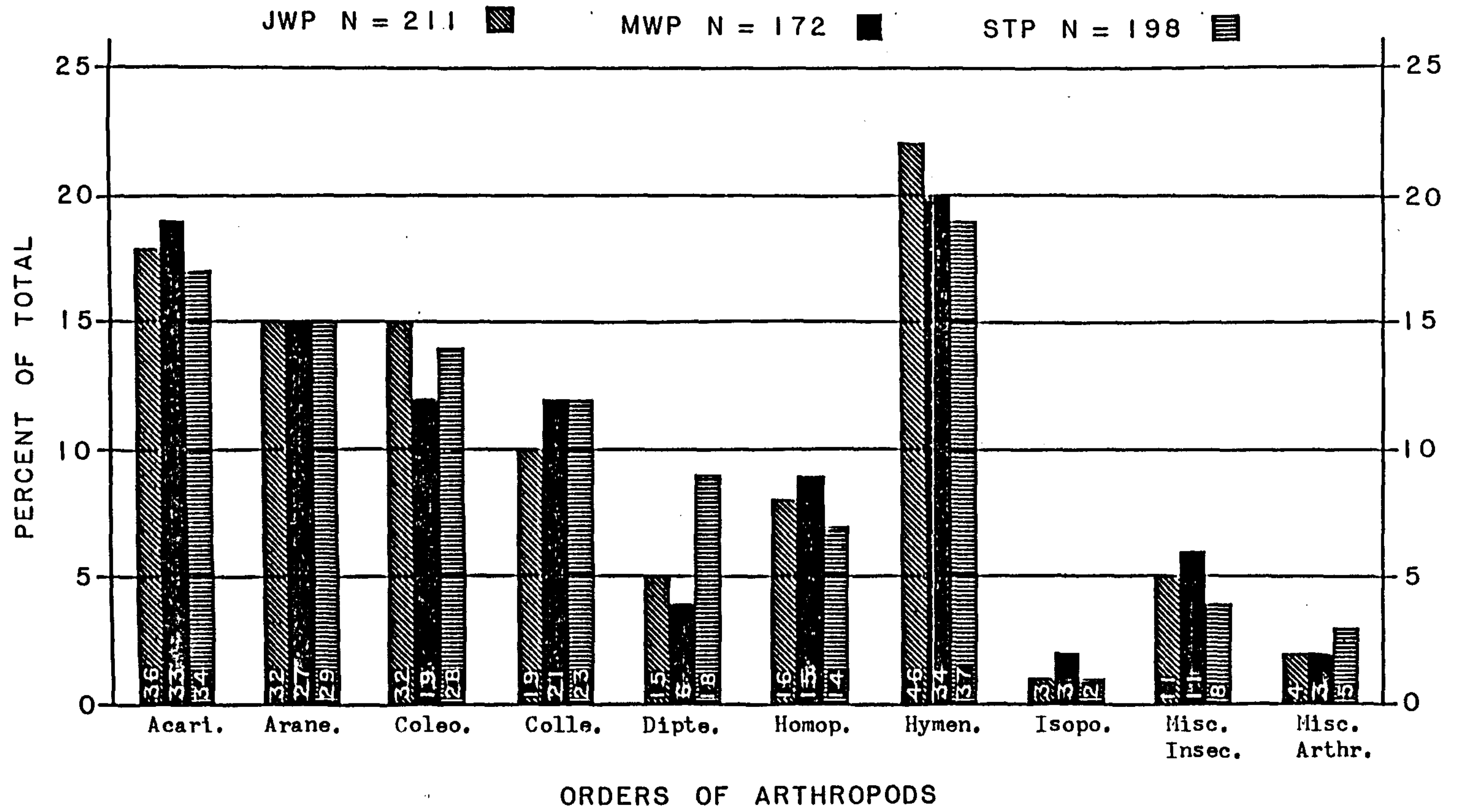


Table 7. Number of Arthropod Species/Order

Order	JWP Total	JWP Rank	MWP Total	MWP Rank	STP Total	STP Rank
Acarina	37	(2)	33	(2)	34	(2)
Araneae	32	(3)	26	(3)	29	(3)
Coleoptera	31	(4)	20	(5)	28	(4)
Collembola	20	(5)	21	(4)	23	(5)
Diptera	11	(7)	6	(8)	18	(6)
Hemiptera	1	(13)	1	(11)	3	(9)
Homoptera	16	(6)	15	(6)	14	(7)
Hymenoptera	46	(1)	34	(1)	37	(1)
Isopoda	3	(10)	3	(9)	2	(11)
Lepidoptera	4	(8)	-		-	
Lithbiomorpha	1	(13)	1	(11)	1	(12)
Opiliones	2	(11)	1	(11)	3	(9)
Orthoptera	2	(11)	3	(9)	4	(8)
Polydesmida	-		-		1	(12)
Spirobolida	1	(13)	1	(11)	-	
Thysanoptera	4	(8)	7	(7)	1	(12)

of concealment and a diverse beetle fauna would therefore be discouraged in this type of habitat. In addition to the open nature of a prairie, this study did not use the best trapping method for capturing sedentary and cryptic arthropods because catches can be influenced by both biotic and abiotic factors (Briggs 1961, Greenslade 1964, Southwood 1978). For each remnant Formicidae had the highest number of species collected (Table 8). No other study of the prairie arthropod community has ever reported such a diverse number of ant species; JWP 16 species, MWP 14 species and STP 13 species. In his survey of the animal community of an Illinois prairie, Shackleford (1929) described nine species of Formicidae. In their two year study of the Osage prairie in Oklahoma, Risser _et al_. (1981) reported only seven species of ants. Eight species of ants are found in the True Prairies of the Chicago region (Gregg 1944). Four of these ants were collected in this study: _Formica_ _montana_ Emery, _Leptothorax_ _ambiguus_ Emery _Formica_ _integra_ Mayr, and _Polyergus_ _breviceps_ Emery, the latter two being found exclusively in the True Prairie biome. Analysis of ant species common and unique to each remnant illustrated an inverse association with prairie disturbance. Three species of native prairie Formicidae (_F_. _integra_ Mayr, _F_. _montana_ Emery and _P_. _breviceps_ Emery) were trapped only in

Table 8. Dominant Families by Species

JWP		MWP		STP	
Taxa	Total	Taxa	Total	Taxa	Total
Formicidae	(16)	Formicidae	(14)	Formicidae	(13)
Lycosidae	(13)	Lycosidae	(10)	Lycosidae	(12)
Scelionidae	(12)	Sminthuridae	(9)	Entomobryidae	(10)
Staphylinidae	(12)	Entomobryidae	(8)	Staphylinidae	(10)
Entomobryidae	(10)	Staphylinidae	(7)	Ceraphronidae	(8)
Aphididae	(6)	Gnaphosidae	(6)	Erigonidae	(8)
Cicadellidae	(6)	Cicadellidae	(5)	Scelionidae	(8)
Sminthuridae	(6)	Erythraeidae	(5)	Sminthuridae	(8)
Carabidae	(5)	Thripidae	(5)	Cicadellidae	(6)
Diapriidae	(5)			Erythraeidae	(5)
Erigonidae	(5)			Chloropidae	(4)
Cecidomyiidae	(4)			Oribatidae	(4)
Chrysomelidae	(4)				
Erythraeidae	(4)				
Pteromalidae	(4)				
Trombididae	(4)				

the relatively undisturbed JWP site. However, only one ant species, L. ambiguus Emery, was collected at MWP and STP. Although L. ambiguus Emery is found in prairies, it is also collected from oak forests. Since the MWP is bordered by forest with stands of oak trees, the prairie status of this ant species is uncertain, due to possible immigration from these forest sites. The specificity of these ant species in relation to the amount of prairie disturbance could be a good indicator for the stability and health of a prairie remnant. Why L. ambiguus Emery is not present at JWP is unknown, although species distribution and local extinction might have played a role. Lycosidae contained the second highest number of species trapped at all three remnants, with 13 species at JWP, 10 species at MWP and 12 species at STP. In their study of the spider population in a Nebraska prairie, Muma and Muma (1949) found 11 species of Lycosidae and listed this family as one of the four families of Araneae containing the highest number of species. The cursorial spiders, in general, were the dominant guild of Araneae at each remnant. Species of cursorial spiders from JWP, MWP and STP represented 72 percent, 78 percent and 59 percent of thr total respectively and belonged to seven of the eleven families of Araneae collected. Muma and Muma's findings also showed that species of cursorial spiders dominanted the Nebraska prairie. Other dominant families common to all three remnants were Cicadellidae, Entomobryidae, Erythraeidae, Scelionidae, Sminthuridae and Staphylinidae.

The number of individuals found in each order was also consistent for all three remnants (Table 9). Arthropods from the orders Acarina, Collembola and Hymenoptera were the most abundant arthropods taken in each remnant and represented 75 percent of the total at JWP, 87 percent of the total at MWP and 83 percent of the total at STP (Figure 6). Individuals belonging to the families Entomobryidae, Eupodidae, Formicidae, Galumnidae, Oniscidae, Oribatidae and Sminthuridae were dominant in each remnant (Table 10). Shackleford (1929) observed that Formicidae was the most abundant and dominant family found inhabiting prairie remnants in central Illinois. Risser et al. (1981) also indicated that it was the large number of ants present that caused the Hymenopterans to be the most abundant insect group collected. The dominance of Formicidae in the prairie biome is also indicated in this study. Formicidae contained the largest number of individuals of any arthropod family taken at JWP and STP, while being second only to Eupodid mites at MWP (Table 10). Formicidae, therefore not only dominanted the three prairie remnants in terms of number of species, but also in terms of the number of individuals trapped. Of the remaining six families dominant in numbers

Table 9. Number of Arthropod Individuals/Order

Order	JWP		MWP		STP	
	Total	Rank	Total	Rank	Total	Rank
Acarina	658	(1)	980	(1)	975	(3)
Araneae	133	(5)	59	(5)	74	(7)
Coleoptera	46	(8)	36	(7)	132	(6)
Collembola	512	(3)	542	(2)	1,424	(1)
Diptera	15	(9)	7	(11)	65	(8)
Hemiptera	1	(15)	1	(13)	8	(13)
Homoptera	66	(7)	61	(6)	139	(5)
Hymenoptera	595	(2)	371	(3)	1,387	(2)
Isopoda	209	(4)	85	(4)	283	(4)
Lepidoptera	4	(12)	-		-	
Lithobiomorpha	2	(14)	12	(10)	12	(11)
Opiliones	13	(10)	6	(12)	20	(10)
Orthoptera	80	(6)	15	(8)	38	(9)
Polydesmida	-		-		12	(11)
Spirobolida	3	(13)	1	(13)	-	
Thysanoptera	10	(11)	13	(9)	4	(14)

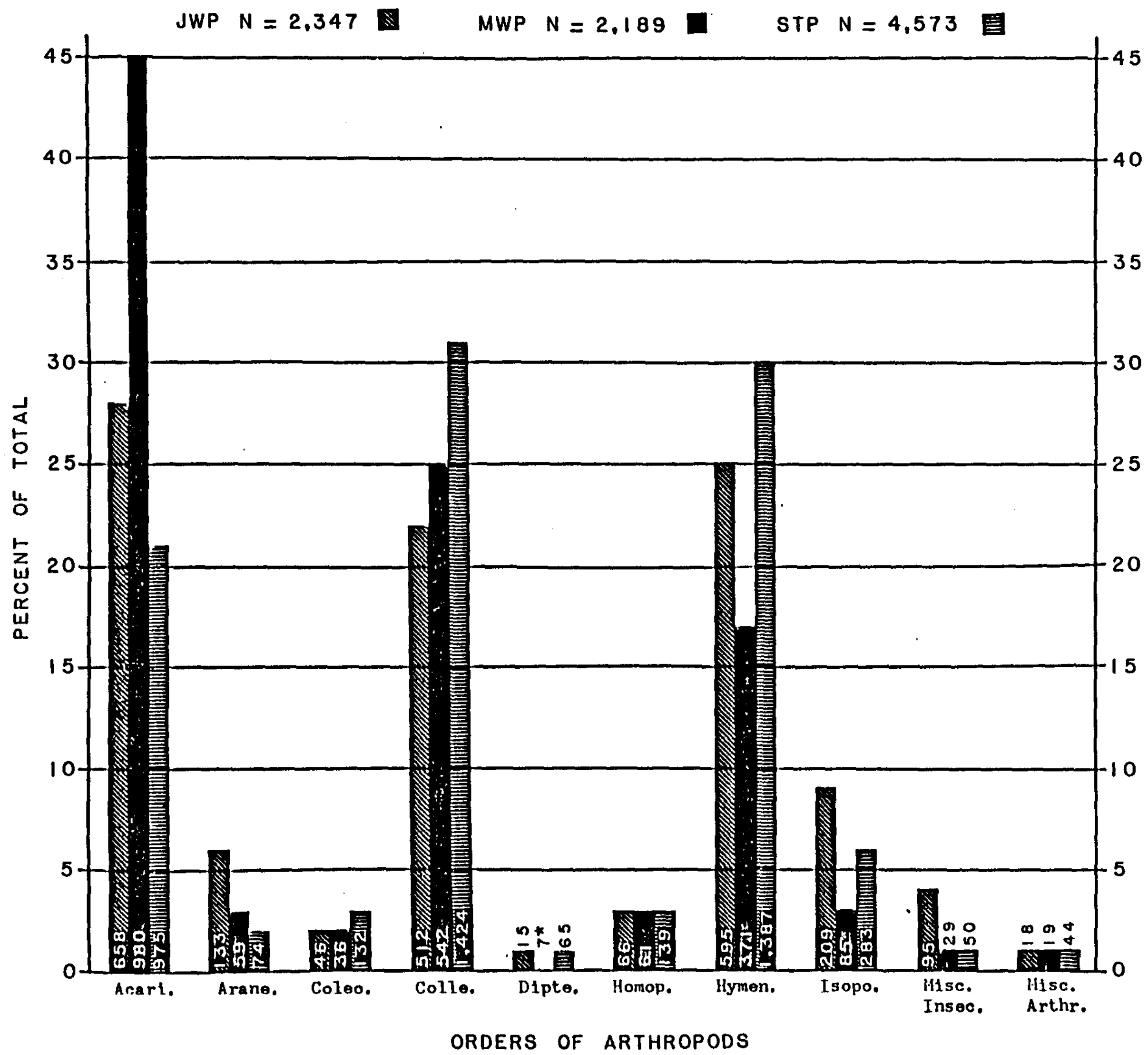


Figure 6. Percent Individuals of Arthropods

Table 10. Dominant Families by Individuals

JWP		MWP		STP	
Taxa	Total	Taxa	Total	Taxa	Total
Formicidae	(496)	Eupodidae	(408)	Formicidae	(1,315)
Entomobryidae	(279)	Formicidae	(335)	Entomobryidae	(1,026)
Oniscidae	(209)	Entomobryidae	(270)	Eupodidae	(436)
Mycobatidae	(190)	Sminthuridae	(256)	Sminthuridae	(343)
Galumnidae	(129)	Erythraeidae	(126)	Oniscidae	(283)
Sminthuridae	(129)	Galumnidae	(104)	Pygmephoridae	(202)
Isotomidae	(99)	Oniscidae	(85)	Cicadellidae	(101)
Lycosidae	(98)	Scheloribatidae	(81)	Staphylinidae	(70)
Oribatidae	(87)	Nanorchestidae	(56)	Galumnidae	(59)
Eupodidae	(85)	Oribatidae	(48)	Oribatidae	(50)

of individuals at all three remnants, five belonged to the microarthropod orders Acarina and Collembola. Data from this study indicate that Acarina and Collembola represented 50 percent of the total at JWP, 70 percent of the total at MWP and 52 percent of the total at STP. This finding is not too surprising. Risser et al. (1981) determined that these two orders of microarthropods (Acarina and Collembola) were extremely numerous, even to a depth of 50 cm below the soil surface, and represented 55 percent of all arthropods taken above ground and 59 percent of the total below ground collection. Seastedt (1984) also estimated a tremendous number of microarthropods inhabiting a prairie in Kansas and observed that burning affects their population numbers. He found a 1.5 times greater number of individuals in an unburned prairie site relative to a burned prairie site. Data from this study supports Seastedt's findings. Microarthropods from the rarely burned MWP contained approximately 1.4 times more individuals than the regularly burned JWP and the irregularly burned STP. The lack of burning at MWP, therefore, is probably the main reason why there was such a disproportionately high number of Acarina found at this site. The relatively low numbers of microarthropods at STP may not be related to burning, but could be a result of high moisture content since all traps were placed exclusively in the wet-mesic portion of this site.

Family level similarity for all three remnants was high (63 percent), while species and individual level similarities were low (28 and 23 percent, respectively) (Table 11). Therefore, although the majority of arthropod families in this study are common to all three study sites, species of arthropods are for the most part distinct and unique to each prairie remnant. The reason for this dissimilarity of species is unknown but could involve local extinction of certain species at one site, but not the others. All remnants have undergone ecological stress due to human population growth. For example, JWP has gradually been reduced from 50.99 ha to 2.14 ha in a period of approximately 120 years (Rouffa, unpublished). JWP and MWP are more similar to each other than either is to STP. This similarity is most likely due to the close proximity of these remnants to each other.

The diversity data for each remnant are listed in Table 12. Individual and species richness for all three remnants were significantly different. A Tukey test indicated that the data from STP was the reason for the difference in both cases. Both mean numbers of individuals and species caught at STP were much higher than at either JWP or MWP. However, for species diversity and evenness there was no significant difference between remnants ($P > 0.10$ and $P > 0.25$ respectively). These conflicting results may lend credence to the criticisms of Hurlbert (1971) and

Table 11. Arthropod Similarity Indices

Comparison	Family	Species	Individual
Two-way Comparisons			
JWP vs MWP	74.2	43.3	40.5
JWP vs STP	69.6	38.6	32.6
MWP vs STP	70.3	40.5	43.4
Three-way Comparison			
JWP vs MWP vs STP	63.4	28.4	23.0

Table 12. Arthropod Diversity Indices and Comparitive Test Values

Statistics	JWP	MWP	STP
Indices			
Mean individual richness (n)	156.47	145.93	304.87
Mean species richness (k)	34.27	33.27	44.40
Median Brillouin's diversity index (H)	1.11	1.12	1.15
Median Pielou's evenness (J)	0.76	0.76	0.74
Kruskal-Wallis Test Values*			
n		13.69	
k		14.03	
H		2.90	
J		2.01	

* Hc, 0.05, 15, 15, 15 = 5.99

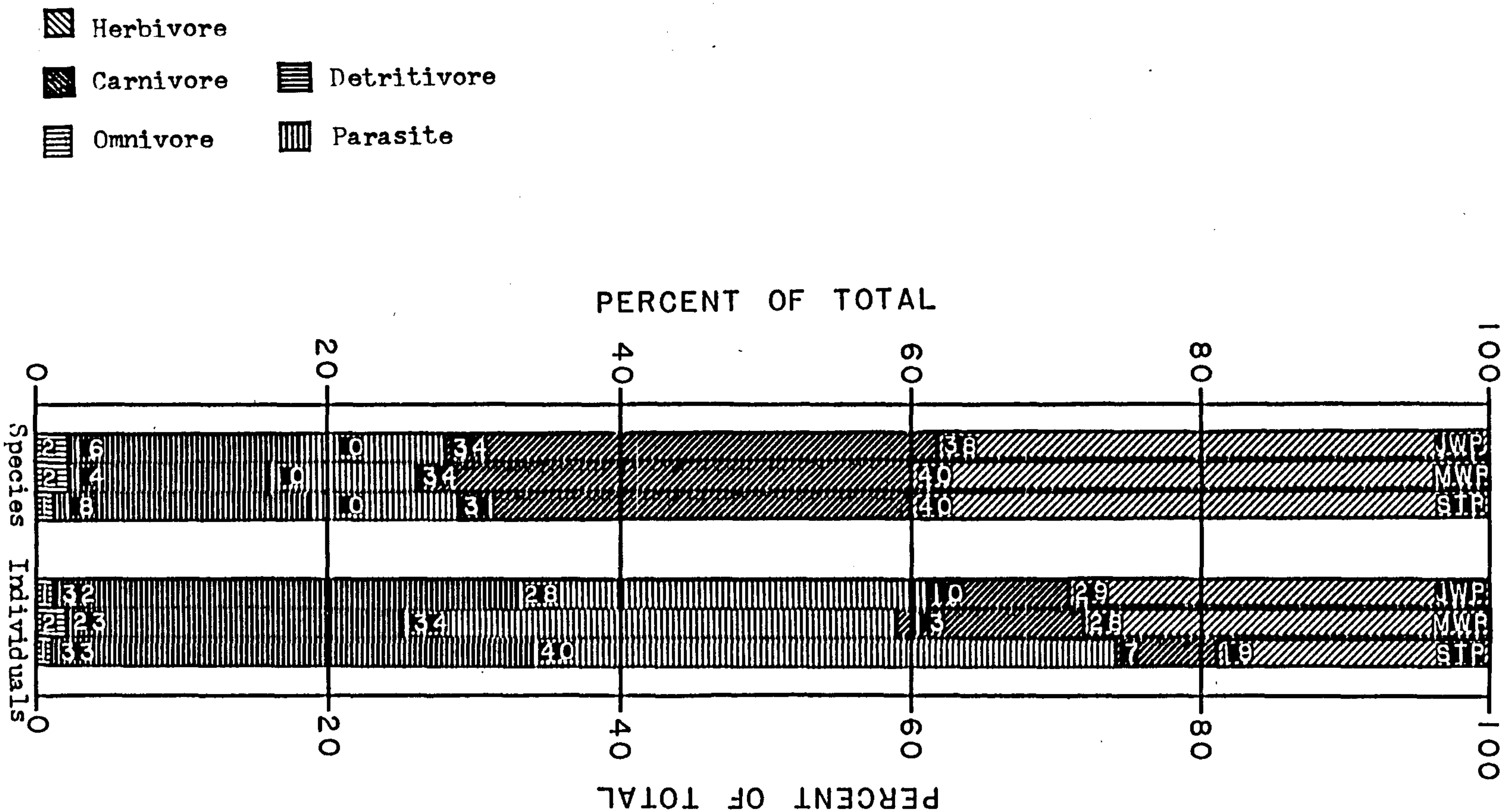
Peet (1974, 1975) who concluded that diversity indices and their evenness counterparts are at best inadequate because of their high sensitivity to sample size and stochastic variation. The major difference between STP and the other two prairie sites was size, which implicates the classical species-area relationship (Preston 1960, 1962, Williams 1964, MacArthur and Wilson 1967, Simberloff 1972). Connor and McCoy (1979) reported that increased area is correlated with increases of species number because increased area may include more varied habitats and may also allow larger populations which will not be as susceptable to random extinction. Another possible reason why STP exhibited a larger species and individual richness, in addition to its own relatively large size, is the fact that this remnant lies adjacent to the Gensburg-Markham Prairie Preserve. This preserve would act as a source pool or "feeder" area. However, as reported early, JWP contained the highest number of species collected relative to the other study sites (Table 5). Murdock et al. (1972) showed that insect species diversity, evenness and number were positively correlated with corresponding plant species diversity parameters. This diversity relationship is illustrated in the data; as the degree of disturbance increases, the number of prairie plant species decreases and the number of arthropod species found decreases. Therefore, these results suggest that prairie remnant size and the surrounding feeder areas, as well as prairie plant diversity, could play key roles in the arthropod diversity.

All remnants exhibited similar percent compositions of adult arthropods at each trophic level (Table 13). Figure 10 illustrates the trophic level relationships of the adult arthropods found at each prairie remnant. Species of herbivores were dominant at each site, representing 38 to 40 percent of the total. Species of carnivores were the second largest group trapped and composed 31 to 34 percent of the total. These trophic groups were followed by detritivores (14 to 18 percent of the total), omnivores (10 percent of the total) and parasites (1 to 2 percent of the total). Evans and Murdoch (1969) found that 85 percent of all insects collected were herbivores, 12 percent carnivores and 3 percent other. Since their study concentrated only on the winged insects of the foliage level biotope a very high percentage of herbivores would be expected. This study concentrated on all arthropods from the soil surface, a level abundant with detritus feeders and scavengers. Therefore, a higher percentage of detritivores and a lower percentage of herbivores should be found and is in fact reflected by the data. Arthropods belonging to the family Lycosidae were the dominant carnivores at each site, with Staphylinidae also being found in relatively large numbers. Nagel (1979) also found Lycosidae to be the most important

Table 13. Adult Arthropod Trophic Level Data

Study Site	Taxonomic Level	Trophic Level: Herbivore	Carnivore	Omnivore	Detritivore	Parasite
JWP	Species	81 (38%)	72 (34%)	21 (10%)	33 (16%)	4 (2%)
	Individuals	688 (29%)	235 (10%)	664 (28%)	754 (32%)	6 (1%)
MWP	Species	69 (40%)	59 (34%)	17 (10%)	24 (14%)	3 (2%)
	Individuals	602 (28%)	281 (13%)	753 (34%)	507 (23%)	46 (2%)
STP	Species	79 (40%)	61 (31%)	20 (10%)	36 (18%)	2 (1%)
	Individuals	885 (19%)	321 (7%)	1832 (40%)	1511 (33%)	24 (1%)

Figure 7. Percent Trophic Level Composition of Adult Arthropods



predator on a mixed prairie in Nebraska. Individuals of omnivores comprised the greatest number of arthropods collected (28 to 40 percent of the total), followed by detritivores (23 to 33 percent of the total), herbivores (19 to 29 percent of the total), carnivores (7 to 13 percent of the total) and parasites (1 to 2 percent of the total). The large number of omnivores reported at JWP and STP was due primarily to the high number of ants trapped, which are primarily scavangers. Formicidae from JWP and STP represented 75 percent and 72 percent of all omnivores respectively. The relatively low percentage of Formicidae at MWP (44 percent of total) was due to a large number of Eupodidae, another scavanger, which comprised 54 percent of all omnivores taken at this remnant. A high abundance of detritivores was also seen. This group was primarily composed of several families of microarthropods. It has been suggested that the recycling of organic matter by detritivores and scavangers may be the most important activity of invertebrates of the True Prairie (Risser et al. 1981). The large numbers of detritivores and scavangers observed at the soil level biotope in this study imply a significant role for these arthropods in these remnants. Immature trophic levels were inferred from the corresponding adults collected and they indicated that species from seventeen families had immature feeding habits different from that of the adults. Furthermore, all but three of these families contained parasitoid immatures. Seventy-nine percent of the parasitoids (i.e. adults having parasitoid immatures) taken belonged to the order Hymenoptera and comprised 57 percent of all hymenopterans trapped at JWP, 47 percent at MWP and 59 percent at STP. The most dominant parasitoids belonged to the families Scelionidae, Ceraphronidae and Diapriidae. Evans and Murdoch (1969) also found that the principal difference between the immature and adult trophic levels was due to this large increase of hymenopterous parasitoid species. They also reasoned that the large percentage of insect species (49 percent) which at some stage in their life cycle feed on other insects indicated a stabilizing mechanism. Other studies have also indicated that in complex communities predation is probably the dominant factor affecting diversity and therefore, has an impact on population regulation and stability (Merge and Sutherland 1976, Krebs 1978, Risser et al. 1981). Data from the three prairie sites exhibit a similar percent composition, with species of carnivores and parasitoids representing 52 percent at JWP, 50 percent at MWP and 46 percent at STP. The similarity of these percent compositions imply that this stabilizing mechanism may also be working on the arthropod communities at these three sites. Another interesting feature of the trophic composition is the large number of carnivore species, but relatively few individuals and the large number of detritivore and omnivore individuals, but relatively few species. MacArthur (1955) proposed that stability could be achieved in one of two ways, either by a large number of species each with a restricted diet or a smaller number of species each with a wider diet. Trophic level composition data from this study imply that both of these mechanisms are present. First, the large number of carnivore species present prey on the few species of detritivore and omnivore arthropods found in large numbers (restricted diet). Second, the small number of detritivore and omnivore species present feed on the detritus which is found in abundance at the soil level biotope (wider diet). Therefore, two mechanisms seem to be involved in maintaining a stable arthropod community at the soil level biotope.

Since great similarity exists between the three prairie remnants sampled in this study, the arthropod data gathered from this study were pooled and further evaluated as composite data (CMP). Pooling the data is feasible because each of these isolated remnants once belonged to the same vast prairie peninsula that covered sixty percent of Illinois and therefore, can be considered as three sites from this peninsula. Arthropods collected from all three remnants totaled 9,109 individuals, representing 16 orders, 113 families and 400 species (Table 14).

Table 14. Composite Data - Family, Species and Individual Numbers/Order

Order	Family		Species		Individual	
	Total	Rank	Total	Rank	Total	Rank
Acarina	25	(1)	66	(2)	2,613	(1)
Araneae	11	(6)	65	(3)	266	(5)
Coleoptera	13	(4)	65	(3)	214	(7)
Collembola	3	(8)	28	(6)	2,478	(2)
Diptera	15	(3)	29	(5)	87	(9)
Hemiptera	2	(10)	4	(9)	10	(14)
Homoptera	12	(5)	33	(7)	266	(5)
Hymenoptera	17	(2)	85	(1)	2,353	(3)
Isopoda	1	(12)	4	(9)	577	(4)
Lepidoptera	4	(7)	4	(9)	4	(15)
Lithobiomorpha	1	(12)	1	(14)	26	(12)
Opiliones	1	(12)	3	(13)	39	(10)
Orthoptera	3	(8)	4	(9)	133	(8)
Polydesmida	1	(12)	1	(14)	12	(13)
Spirobolida	1	(12)	1	(14)	4	(15)
Thysanoptera	2	(10)	9	(8)	27	(11)
Total	113		400		9,109	

Although a few differences exist between the composite data and the individual site data the results in general are similar. One difference, however, is observed in family dominance. Families from the three orders Acarina, Diptera and Hymenoptera comprised 50 percent of all families collected (Table 14). Dipterous, as well as, homopterous families both became more prominent when the prairie site data was pooled. This suggests that very little family similarity exists within these two orders at each of the three remnants and in fact, only six (Aphididae, Cicadellidae, Pseudococcidae, Cecidomyiidae, Phoridae and Sphaeroceridae) of the 27 families from these orders inhabited all three remnants. Although the reasons for this dissimilarity is unknown, many of the Diptera and Homoptera collected from this study were degenerate or wingless forms and/or detritivores and would therefore be associated with the soil level biotope, indicating that the trapping method is not suspect. Of those Diptera and Homoptera that were winged, catches were most likely due to the arthropod foraging at the surface for organic matter, although the attractive nature of the killing-preservative and chance could have influenced a small percentage of catches.

Species from the four orders Acarina, Araneae, Coleoptera and Hymenoptera represented 69 percent of all species taken, each accounting for over sixty species

(Table 14). The three orders Collembola, Diptera and Homoptera were each represented by more than 25 species and composed 23 percent of the total. Evans et al. (1969) found that species of Hymenoptera and Diptera were dominant (62 percent) in an old field. There are two reasons for the differences between their study and this work. First, Evans et al. (1969) did not include either apterygote insects or arachnids in their survey. Second, they utilized a malaise trap as one of their collecting methods and this trap is especially effective in catching winged Diptera and Hymenoptera. The four dominant families in the composite data were Formicidae, Lycosidae, Scelionidae and Staphylinidae. Each contained over fifteen species and represented 21 percent of all species collected (Table 15). Formicidae, however, did not contain the highest number of species. It ranked third in the composite data, but still contained a large number of species.

Individuals from the three orders Acarina, Collembola and Hymenoptera were dominant and represented 82 percent of all arthropods collected (Table 14). The twenty families containing the highest number of individuals collected are listed in Table 16. Individuals from the family Formicidae were clearly the most numerous and represented 24 percent of all arthropods trapped. Other commonly caught families included Entomobryidae (17 percent) and Eupodidae (10 percent).

Table 15. Composite Data - Dominant Families by Species

Taxa	Total
Lycosidae	(23)
Staphylinidae	(23)
Formicidae	(22)
Scelionidae	(16)
Ceraphronidae	(11)
Cicadellidae	(11)
Entomobryidae	(10)
Erigonidae	(10)
Gnaphosidae	(10)
Sminthuridae	(10)
Carabidae	(9)
Diapriidae	(9)
Aphididae	(7)
Cecidomyidae	(7)
Chrysomelidae	(7)
Thripidae	(7)
Bdellidae	(6)
Oribatidae	(6)

Table 16. Composite Data - Dominant Families by Individuals

Taxa	Total
Formicidae	(2,146)
Entomobryidae	(1,575)
Eupodidae	(929)
Sminthuridae	(728)
Oniscidae	(577)
Galumnidae	(292)
Pygmephoridae	(207)
Mycobatidae	(190)
Oribatidae	(185)
Erythraeidae	(181)
Lycosidae	(168)
Scheloribatidae	(156)
Isotomidae	(152)
Cicadellidae	(135)
Gryllidae	(123)
Scelionidae	(123)
Staphylinidae	(95)
Nanorchestidae	(75)

CONCLUSIONS

1. Three distinct levels of disturbance are seen at the three sites in this study, however, prairie indicator grasses and forbs, as well as, NARI values indicate that these remnants still posses enough botanical integrity and quality to be considered a True Prairie and, therefore, should be considered very important parcels of land.

2. MWP is an extremely disturbed prairie remnant and, as would be expected, contained the fewest number of arthropod families, species and individuals. However, MWP was not statistically different from the other two study sites with respect to species diversity and evenness. Furthermore, MWP was not satistically different from JWP with respect to species and individual richness. Therefore, although disturbance greatly effects the flora of the True Prairie and may, therefore, influence the number of arthropod species, it seems to cause little effect on the soil level biotope prairie arthropod community in general.

3. Acarina and Hymenoptera are the dominant True Prairie arthropod orders from the soil level biotope in terms

of the number of families, species and individuals present.

4. The family Formicidae was the predominant group of True Prairie arthropods relative to the number of species and individuals found. Species of Formicidae native to the True Prairie biome appear to be good indicators of prairie remnant disturbance and degree of remnant health.

5. The arthropod community from the soil level biotope exhibits large degrees of similarity at each of the three prairie remnants studied in this report with respect to species and individual percent composition of orders and trophic structure. These observations seem to indicate that arthropod communities at these prairie sites are stable.

6. Similarity indices show that the majority of arthropod families from the soil level biotope are common to all three study sites, however, species of arthropods are for the most part distinct and unique to each prairie remnant. This implies stability within each of these arthropod communities, with species divergence due to separation, isolation and local extinction.

7. There is a positive correlation between the size of a prairie remnant and arthropod species and individual richness, as well as, between the prairie plant species diversity found within a remnant and the number of arthropod species inhabiting that remnant. Prairie remnant size and plant species diversity, therefore, seem to be key factors in determining the degree of arthropod diversity found at the soil level biotope in the True Prairie.

8. Dominant carnivores belonged to the families Lycosidae and Staphylinidae, while dominant parasitoids belonged to the families Scelionidae, Ceraphronidae and Diapriidae. Their feeding habits and reproductive strategies might play a significant role in regulating the prairie arthropod community in terms of stability and diversity.

9. Dominant detritivores were the microarthropods, especially those belonging to the families Entomobryidae and Sminthuridae. As would be expected from the soil level biotope, larger numbers of species and individual detritivores were observed in this study at the expense of herbivores. The most important activity of arthropods in the True Prairie may be the recycling of organic matter by detritivores.

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APPENDIX A

SAS PROGRAMS

SAS Program for Brillouin's Diversity Index

```
//@L08DGS JOB (E708R,014,,9),`STATHAKIS',TIME=(0,02),
  CLASS=0,MSGCLASS=X
// EXEC SAS
//SYSIN DD *
DATA;
INPUT SITE S JAR S FAMILY S SP S F;
IF JAR EQ `X##' THEN SUMF = (F + 0.5) * LOG10 (F) -
0.4343 * F + 0.3991;
CARDS:
PROC SORT; BY JAR;
PROC MEANS; BY JAR; VAR SUMF; VAR F;
PROC PRINT; TITLE `PRAIRIE NAME';
```

APPENDIX B

PRAIRIE PLANT LIST

NR	SCIENTIFIC NAME	JWP	MWP	STP
8	Agropyron trachycaulum unilaterale	+	-	-
1	Agrostis hyemalis	-	-	+
6	Allium cernuum	+	+	+
10	Amorpha canescens	+	*	-
4	Andropogon gerardii	+	+	+
5	Andropogon scoparius	+	*	+
2	Anemone cylindrica	+	+	-
10	Asclepias sullivantii	+	+	+
10	Asclepias tuberosa	+	*	-
8	Aster azureus	+	-	+
5	Aster ericoides	+	+	+
8	Aster laevis	+	+	-
4	Aster novae-angliae	+	+	+
15	Aster ptarmicoides	+	-	+
5	Aster puniceus firmus	-	-	+
3	Aster simplex	+	-	+
8	Baptisa leucantha	+	+	-
15	Baptisa leucophaea	+	-	+
15	Bromus kalmii	+	+	-
15	Cacalia tuberosa	+	*	+
3	Calamagrostis canadensis	+	-	+
10	Carex bicknellii	-	-	+
5	Cassia fasciculata	-	-	+
15	Castilleja coccinea	-	-	+
8	Ceanothus americanus	-	+	-
2	Cirsium discolor	+	+	+
20	Cirsium hillii	+	-	-
7	Comandra richardsiana	+	-	+
8	Coreopsis palmata	+	-	-
5	Coreopsis tripteris	+	+	+
4	Desmodium canadense	+	+	+
6	Dodecatheon meadia	+	+	+
4	Elymus canadensis	+	*	+
4	Erigeron philadelphicus	+	-	-
9	Eryngium yuccifolium	+	*	+
1	Eupatorium serotinum	-	-	+
2	Euphorbia corollata	-	-	+
7	Galium boreale	+	-	+
5	Galium obtusum	+	-	+
7	Gentiana andrewsii	+	+	-
10	Gentiana crinita	-	*	+
10	Gentiana puberula	+	-	-
15	Gentiana saponaria	-	-	+

NR	SCIENTIFIC NAME	JWP	MWP	STP
15	Gerardia aspera	+	+	-
7	Gerardia purpurea	-	-	+
5	Helenium autumnale	-	+	+
2	Helianthus grosseserratus	+	+	+
8	Helianthus laetiflorus rigidus	+	*	-
9	Helianthus mollis	-	-	+
8	Heuchera richardsonii	+	+	+
9	Hierochloe odorata	-	+	-
9	Houstonia caerulea	-	-	+
10	Hypoxis hirsuta	+	+	+
4	Juncus dudleyi	+	+	+
7	Koeleria cristata	+	-	-
7	Krigia biflora	+	+	+
8	Lathyrus palustris	+	-	+
8	Lathyrus venosus	+	+	-
4	Lespedeza capitata	+	+	+
6	Liatris aspera	+	+	+
6	Liatris spicata	+	+	+
6	Lilium michiganese	+	+	+
15	Lilium philadelphicum andinum	+	-	-
6	Lithospermum canescens	+	*	-
5	Lobelia spicata	+	+	+
7	Lysimachia lanceolata	-	-	+
9	Lysimachia quadriflora	+	-	+
7	Lythrum alatum	+	+	+
15	Oenothera perennis	-	+	-
10	Oenothera pilosella	-	+	+
15	Oenothera tetragona longistipata	+	-	-
15	Oxalis violacea	+	-	-
7	Oxypolis rigidior	+	+	+
7	Panicum lanuginosum fasciculatum	-	-	+
10	Panicum leibergii	+	-	-
7	Panicum oligosanthes scribnerianum	-	-	+
5	Panicum virgatum	+	+	+
7	Parthenium integrifolium	+	+	+
10	Pedicularis canadensis	+	+	+
7	Pedicularis lanceolata	-	+	-
4	Penstemon digitalis	-	-	+
15	Petalostemum candidum	+	-	-
9	Petalostemum purpureum	+	*	+
7	Phlox glaberrima interior	+	*	+
6	Phlox pilosa	+	*	-
5	Physostegia virginiana	-	*	+
6	Polygala sanguinea	-	-	+
8	Polygala senega	+	-	-
9	Potentilla arguta	+	*	+
4	Potentilla simplex	+	+	+
8	Prenanthes aspera	+	-	-
8	Prenanthes racemosa	+	+	-

NR	SCIENTIFIC NAME	JWP	MWP	STP
15	Psoralea tenuiflora	+	-	-
8	Pycnanthemum tenuifolium	-	+	-
5	Pycnanthemum virginianum	+	+	+
4	Ratibida pinnata	+	+	+
5	Rosa carolina	+	+	-
1	Rudbeckia hirta	+	+	+
6	Salix humilis	-	-	+
7	Scutellaria parvula leonardii	+	+	+
6	Senecio pauperculus balsamitae	+	+	+
5	Silphium integrifolium	+	+	+
5	Silphium laciniatum	+	*	+
5	Silphium profoliatum	-	+	-
5	Silphium terebinthinaceum	+	+	-
7	Sisyrinchium albidum	+	+	+
15	Sisyrinchium montanum	-	+	-
5	Smilacina stellata	+	+	+
3	Solidago graminifolia nuttallii	+	+	+
5	Solidago gymnospermoides	-	-	+
4	Solidago nemoralis	+	+	+
7	Solidago riddellii	+	+	+
4	Solidago rigida	+	+	+
7	Solidago speciosa	-	+	-
5	Sorghastrum nutans	+	+	+
5	Spartina pectinata	+	+	+
7	Spiranthes cernua	+	-	-
9	Sporobolus heterolepis	+	*	+
5	Stachys palustris homotricha	+	-	+
6	Stipa spartea	+	-	-
2	Tradescantia ohiensis	+	+	+
10	Valeriana ciliata	+	-	-
4	Verbena hastata	+	-	+
5	Vernonia fasciculata	-	+	+
6	Veronicastrum virginicum	+	+	+
15	Viola fimbriatula	-	-	+
10	Viola pedatifida	+	+	-
7	Viola sagittata	-	+	-
7	Zizia aurea	+	+	+

· Key

NR native rating value (Swink and Wilhelm 1979)

+ indicates plant species is found in prairie remnant

- indicates plant species is not found in prairie remnant

* indicates plant species was introduced since 1978 and not included in the analysis

APPENDIX C

PITFALL TRAPPED ARTHROPOD LIST

The number of individuals collected for each arthropod species is indicated under each study site heading. A dash signifies that that particular species was not trapped at that site.

	JWP	MWP	STP
ACARINA			
Anystidae (Pd, Pd)			
Anystis sp.	-	-	23
Bdellidae (Pd, Pd)			
Undetermined sp.	1	5	1
Undetermined sp.	1	2	-
Undetermined sp.	2	-	-
Undetermined sp.	-	4	-
Undetermined sp.	-	2	-
Undetermined sp.	-	-	2
Bimichaelidae (Hb, Hb)			
Undetermined sp.	28	41	2
Cunaxidae (Pd, Pd)			
Undetermined sp.	21	-	-
Undetermined sp.	-	6	-
Erythraeidae (Pd, Pr)			
Undetermined sp.	2	20	2
Undetermined sp.	3	-	-
Undetermined sp.	1	66	3
Undetermined sp.	2	-	-
Undetermined sp.	-	36	26
Undetermined sp.	-	3	-
Undetermined sp.	-	-	16
Undetermined sp.	-	-	2
Eupodidae (Om ,Om)			
Eupodes sp.	85	408	436
Galumnidae (Hb, Hb)			
Galumna virginiensis Jacot	129	103	45
Undetermined sp.	-	1	-
Undetermined sp.	-	-	11
Undetermined sp.	-	-	3

Laelapidae (Pr, Pr)			
Undetermined sp.	3	31	21
Undetermined sp.	1	-	-
Undetermined sp.	-	12	-
Undetermined sp.	-	-	3
Mochlozetidae (Dt, Dt)			
<u>Podoribates</u> <u>pratensis</u> (Banks)	13	1	-
Mycobatidae (Hb, Hb)			
<u>Pelopsis</u> <u>bifurcata</u> (Ewing)	182	-	-
<u>Punctoribates</u> sp.	8	-	-
Nanorchestidae (Hb, Hb)			
<u>Speleorchestes</u> sp.	5	48	13
Undetermined sp.	-	7	-
Undetermined sp.	-	1	-
Undetermined sp.	-	-	1
Oribatulidae (Dt, Dt)			
<u>Zygoribatula</u> sp.	82	-	-
<u>Zygoribatula</u> <u>rostrata</u> Jacot	1	36	30
<u>Lucoppia</u> sp. nr. <u>burrowsi</u>(Michael)	4	13	-
Undetermined sp.	-	-	16
Undetermined sp.	-	-	1
Undetermined sp.	-	-	3
Parasitidae (Pd, Pr)			
Undetermined sp.	4	1	3
Pygmephoridae (Hb, Hb)			
Undetermined sp.	4	1	185
Undetermined sp.	-	-	17
Rhagidiidae (Pd, Pd)			
Undetermined sp.	4	26	6
Rhodacaridae (Pd, Pd)			
Undetermined sp.	2	-	6
Undetermined sp.	3	-	-
Undetermined sp.	2	2	-
Undetermined sp.	-	-	1
Scheloribatidae (Dt, Dt)			
<u>Scheloribates</u> sp.	23	48	4
<u>Scheloribates</u> <u>milleri</u> Jacot	5	33	43
Scutacaridae (Pr, Pr)			
Undetermined sp.	1	3	-

Tarsonemidae (Om, Om)			
Undetermined sp.	2	-	-
Undetermined sp.	1	-	-
Undetermined sp.	-	-	1
Tegoribatidae (Hb, Hb)			
Undescribed sp.	-	5	-
Tenupalpidae (Hb, Hb)			
Undetermined sp.	-	-	2
Trombidiidae (Pd, Pr)			
Allotrombiinae sp.	1	1	-
Allotrombiinae sp.	3	1	-
Microtrombidiinae sp.	7	13	-
Microtrombidiinae sp.	4	-	-
Tydeidae (Om, Om)			
Undetermined sp.	-	-	41
Undetermined sp.	-	-	5
Undetermined sp.	-	-	1
Uropodidae (Dt, Dt)			
Undetermined sp.	1	-	-
Winterschmidtiidae (Dt, Dt)			
Undetermined sp.	18	-	-
ARANEAE			
Agelenidae (Pd, Pd)			
<u>Agelenopsis</u> <u>pensylvanica</u> (Koch)	5	-	-
<u>Cicurina</u> sp.	1	-	-
Clubionidae (Pd, Pd)			
<u>Clubiona</u> <u>abbotti</u> Koch	1	-	1
Undetermined sp.	1	-	-
Dictynidae (Pd, Pd)			
<u>Dictyna</u> sp.	1	-	-
<u>Argenna</u> <u>obesa</u> Emerton	1	-	-
Undetermined sp.	1	-	-
Undetermined sp.	-	-	1
Erigonidae (Pd, Pd)			
<u>Ceraticellus</u> <u>emertoni</u> (Cambridge)	1	-	3
<u>Erigone</u> <u>autumnalis</u> Emerton	3	3	1
<u>Eperigone</u> <u>trilobata</u> (Emerton)	1	1	2
<u>Islandiana</u> <u>flaveola</u> (Banks)	1	1	-
<u>Ceratinopsis</u> <u>laticeps</u> Emerton	1	-	-
Undetermined sp.	-	-	1
Undetermined sp.	-	-	2
Undetermined sp.	-	-	2

Undetermined sp.	-	-	2
Undetermined sp.	-	-	1
Gnaphosidae (Pd, Pd)			
Drassylus rufulus (Banks)	1	-	-
Micaria sp.	1	-	-
Undetermined sp.	1	1	-
Undetermined sp.	-	1	-
Undetermined sp.	-	1	-
Undetermined sp.	-	1	-
Undetermined sp.	-	1	-
Undetermined sp.	-	2	-
Undetermined sp.	-	1	-
Undetermined sp.	-	-	5
Hahniidae (Pd, Pd)			
Neoantistea agilis (Keyserling)	1	-	-
Linyphiidae (Pd, Pd)			
Meioneta unimoculata (Banks)	7	4	3
Meioneta sp. (not *unimacujlata*)	-	-	1
Bathyphantes pallida (Banks)	-	2	-
Bathyphantes concolor (Wider)	-	1	-
Undetermined sp.	-	-	1
Lycosidae (Pd, Pd)			
Schizocosa avida (Walckenaer)	-	2	-
Pardosa saxatills (Hentz)	58	10	8
Pirata aspirans Chamberlin	8	-	-
Pirata minutus Emerton	9	4	2
Pirata piraticus (Clerck)	1	-	-
Pirata insularis Emerton	1	-	-
Lycosa frondicola Emerton	3	-	2
Pardosa sp. nr. *saxatilis* (Hentz)	6	1	-
Pirata sp.	3	-	-
Pirata sp. nr. *minutus* Emerton	3	-	5
Pirata sp. nr. *minutus* Emerton	1	-	1
Pardosa sp.	1	2	-
Pardosa sp.	3	2	-
Pirata sp. nr. *piraticus* (Clerck)	1	-	-
Undetermined sp.	-	2	-
Undetermined sp.	-	1	3
Undetermined sp.	-	1	-
Undetermined sp.	-	2	2
Undetermined sp.	-	-	1
Undetermined sp.	-	-	15
Undetermined sp.	-	-	2
Undetermined sp.	-	-	1
Undetermined sp.	-	-	2
Salticidae (Pd, Pd)			
Icius or *Hentzia* sp.	1	-	1

Tetragnathidae (Pd, Pd)			
Pachygnatha tristriata Koch	-	1	-
Thomisidae (Pd, Pd)			
Ozyptila georgiana Keyserling	5	1	-
Xysticus sp.	-	1	-
Undetermined sp.	-	8	-
Undetermined sp.	-	-	2
Undetermined sp.	-	-	1
COLEOPTERA			
Carabidae (Pd, Pd)			
Poecilus lucublandus Say	-	-	2
Tachys incurvus Say	1	-	-
Bembidion affine Say	1	-	-
Bembidion sp.	1	-	-
Tachys sp.	1	-	-
Amara sp.	1	-	-
Undetermined sp.	-	2	29
Undetermined sp.	-	1	-
Undetermined sp.	-	-	1
Cryptophagidae (Dt, Dt)			
Anchicera sp.	-	-	1
Anchicera sp.	-	-	1
Chrysomelidae (Hb, Hb)			
Trirhabda virgata Le Conte	1	-	-
Paria sp.	1	-	-
Longitarsus subrufus LeConte	3	-	-
Chaetocnema pulichaira Melsheimer	4	-	-
Longitarsus testaceous (Melsheimer)	-	14	1
Trirhabda sp.	-	1	-
Undetermined sp.	-	2	4
Cicindelidae (Pd, Pd)			
Cicindela sexguttata Fabricius	-	1	-
Curculionidae (Hb, Hb)			
Sphenophorus sp.	-	-	1
Tyloderma nigra Casey	2	-	1
Sitona sp.	-	1	-
Sphenophorus sp.	-	1	-
Brachyrhinus ovatus (L.)	-	-	3
Elateridae (Hb, Hb)			
Drasterius amabilis (LeC.)	1	1	-
Conoderus sp.	-	-	2
Conoderus sp.	-	-	1

Lathridiidae (Dt,Dt)			
Corticarina longipennis (LeC.)	3	1	9
Melanophthalma americana (Mann)	-	-	2
Leiodidae (Dt, Dt)			
Anistoma sp.	1	-	-
Undetermined sp.	-	1	-
Anistoma sp.	-	-	1
Mordellidae (Hb, Hb)			
Mordellistena sp.	1	-	-
Nitidulidae (Hb, Dt)			
Stelidota geminata (Say)	1	1	1
Gliscrochilus quadrisignatus (Say)	3	1	-
Epuraea sp.	1	-	-
Phalacridae (Hb, Hb)			
Undetermined sp.	1	-	1
Undetermined sp.	-	-	1
Scydmaenidae (Dt, Dt)			
Sternichnus sp.	1	-	-
Staphylinidae (Pd, Pd)			
Aleocharinae sp.	2	2	-
Aleocharinae sp.	-	-	57
Aleocharinae sp.	-	-	1
Aleocharinae sp.	1	1	-
Apocellus sp.	1	-	-
Oxytelus sp.	1	-	-
Quedius sp.	1	-	-
Quedius sp.	1	-	-
Xantholini sp. (nr. *Philonthus*)	1	-	-
Stenus colonus Erickson	3	-	-
Aleocharinae sp.	3	-	-
Paederus sp.(*littorarius* Gravenhorst)	1	-	1
Aleocharinae sp.	1	-	-
Tachyporus sp.	1	1	1
Scopaeus sp.	-	-	1
Tachyporus sp.	-	1	-
Tachyporus nitidulus (Fabr.)	-	2	-
Mycetoporus sp.	-	1	-
Tachyporus elegans Horn	-	-	1
Mycetoporus sp.	-	-	3
Bryoporus sp.	-	-	2
Anotylus sp.	-	-	1
Xantholini sp.	-	-	2

COLLEMBOLA			
Entomobryidae (Dt, Dt)			
Lepidocyrtus paradoxus Uzel	114	72	547
Lepidocyrtus pellidus Reuter	24	44	60
Entomobrya purpurascens (Packard)	1	19	45
Pseudosinella violenta (Folsom)	5	-	6
Tomocerus flavescens Tullberg	55	11	30
Lepidocyrtus cinereus Folsom	17	23	6
Pseudosinella rolfsi Mills	29	3	58
Orcherella ainsliei Folsom	4	80	58
Lepidocyrtus violaceus Fourcroy	2	-	15
Lepidocyrtus cyaneus Tullberg	28	18	201
Isotomidae (Dt, Dt)			
Isotomurus bimus C & B	32	12	11
Isotoma viridis Bourlet	67	1	26
Folsomia elongata	-	2	-
Undetermined sp.	-	1	-
Poduridae (Dt, Dt)			
Tullbergia nulla C & B	-	-	4
Xynella pseudomaritima James	-	-	7
Pseudachorutes subcrassoides Mills	2	-	-
Xynella grisea Axelson	2	-	-
Hypogastrura sp.	-	-	7
Sminthuridae (Hb, Hb)			
Sminthurinus latimaculosus Maynard	88	45	13
Bourletiella cf/*savona* Maynard	-	87	105
Bourletiella lippsoni Snider	1	70	23
Sminthurides macnamari Folsom & Mills	11	31	102
Sminthurides pumilis (Krausbauer)	7	5	90
Bourletiella spinata (Macgillivray)	1	6	-
Sminthurinus macgillivrayi (Banks)	1	-	-
Sminthurinus cf/*henshawi* (Folsom)	2	1	3
Sminthurus banksi C & B	-	7	3
Dicyrtoma marmorata (Packard)	-	4	4
DIPTERA			
Anthomyiidae (Hb, Hb)			
Undetermined sp.	-	-	1
Cecidomyiidae (Hb, Hb)			
Micromya sp.	1	-	-
Lestodiplosis grassator (Fyles)	1	-	-
Neolasioptera sp.	1	-	-
Resseliella sp.	1	-	-
Undetermined sp.	-	2	-
Undetermined sp.	-	-	2
Undetermined sp.	-	-	1

Chironomidae (Hb, Dt)			
Undetermined sp.	-	1	-
Chloropidae (Hb, Hb)			
Undetermined sp.	-	-	1
Undetermined sp.	-	-	6
Undetermined sp.	-	-	6
Undetermined sp.	-	-	5
Dolichopodidae (Pd, Pd)			
Undetermined sp.	1	-	-
Drosophilidae (Hb, Hb)			
Undetermined sp.	-	-	1
Undetermined sp.	-	-	1
Empididae (Pd, Pd)			
Undetermined sp.	1	-	19
Phoridae (Dt, Dt)			
Undetermined sp.	-	1	5
Undetermined sp.	1	-	-
Undetermined sp.	1	-	1
Psychodidae (Hb, Hb)			
<u>Psychoda</u> sp.	-	1	-
Scatopsidae (Hb, Dt)			
Undetermined sp.	-	-	1
Sciaridae (Dt, Dt)			
<u>Eugnoriste</u> sp.	-	-	4
Undetermined sp.	-	-	3
Undetermined sp.	-	-	1
Sciomyzidae (Pr, Pr)			
Undetermined sp.	1	-	-
Sepsidae (Dt, Dt)			
Undetermined sp.	2	-	-
Sphaeroeridae (Dt,Dt)			
<u>Leptocera</u> <u>fontinalis</u> (Fallen)	4	2	6
Trixoscelididae (Hb, Hb)			
Undetermined sp.	-	-	1

HEMIPTERA			
Lygaeidae (Hb, Hb)			
Ligyrocoris diffusus Uhler	1	-	5
Hypogeocoris piceus (Say)	-	1	-
Undetermined sp.	-	-	2
Miridae (Hb, Hb)			
Undetermined sp.	-	-	1
HOMOPTERA			
Achilidae (Hb, Hb)			
Undetermined sp.	-	1	-
Aclerdidae (Hb, Hb)			
Aclerda ferrisi McConnell	-	-	3
Aphididae (Hb, Hb)			
Acyrthosiphon sp.	1	-	-
Uroleucon sp.	3	-	-
Uroleucon sp.	15	-	-
Uroleucon sp.	8	-	-
Aphis sp.	10	6	-
Capitophorus elaeagni (Del Guercio)	3	1	-
Aphis oenotherae Oestlund	-	-	1
Cicadellidae (Hb, Hb)			
Aceratagallia sanguinolenta (Provancher)	1	5	1
Aphrodes costate (Panzer)	3	-	-
Aphrodes fusofasciata (Goeze)	1	-	-
Stirellus bicolor (Van Duzee)	-	-	4
Doratura stylata (Boheman)	4	3	19
Flexamia praiana De Long	-	-	23
Deltocephalus sp.	3	1	53
Balclutha sp.	4	-	-
Driotura gammaroides (Van Duzee)	-	6	-
Undetermined sp.	-	1	-
Undetermined sp.	-	-	1
Coccidae (Hb, Hb)			
Undetermined sp.	-	4	-
Delphacidae (Hb, Hb)			
Pissonotus sp.	-	1	-
Derbidae (Hb, Hb)			
Undetermined sp.	1	-	-
Diaspididae (Hb, Hb)			
Undetermined sp.	-	1	1

Eriococcidae (Hb, Hb)			
Eriococcus sp.	4	-	-
Eriococcus sp.	2	-	-
Issidae (Hb, Hb)			
Undetermined sp.	-	-	18
Pseudococcidae (Hb, Hb)			
Chaurococcus trifolii (Forbes)	1	-	-
Planococcini sp.	-	1	3
Trionymus sp.	-	27	9
Undetermined sp.	-	2	2
Undetermined sp.	-	1	-
Psyllidae (Hb, Hb)			
Undetermined sp.	-	-	1
HYMENOPTERA			
Andrenidae (Hb, Hb)			
Panurga sp.	-	1	-
Undetermined sp.	1	1	-
Apidae (Hb, Hb)			
Apis mellifera L.	1	-	-
Bethylidae (Pd, Pr)			
Undetermined sp.	-	1	-
Undetermined sp.	-	-	2
Braconidae (Hb, Pr)			
Undetermined sp.	1	-	-
Undetermined sp.	3	-	-
Ceraphronidae (Hb, Pr)			
Undetermined sp.	-	-	6
Undetermined sp.	3	-	2
Undetermined sp.	-	1	-
Undetermined sp.	-	2	-
Undetermined sp.	-	1	-
Undetermined sp.	-	-	13
Undetermined sp.	-	-	1
Undetermined sp.	-	-	1
Undetermined sp.	-	-	1
Undetermined sp.	-	-	1
Undetermined sp.	-	-	2

Diapriidae (Hb, Pr)			
Undetermined sp.	-	1	-
Undetermined sp.	1	1	-
Undetermined sp.	2	-	-
Undetermined sp.	1	-	-
Undetermined sp.	1	-	-
Undetermined sp.	1	-	-
Undetermined sp.	-	2	-
Undetermined sp.	-	-	1
Undetermined sp.	-	-	2
Eumenidae (Pd, Pd)			
Undetermined sp.	1	-	-
Undetermined sp.	-	1	-
Eupelmidae (Hb, Pr)			
Undetermined sp.	-	-	1
Formicidae (Om, Om)			
Formica subsericea L.	99	4	-
Myrmica fractricornis Emery	64	24	488
Aphaenogaster rudis Emery	9	-	88
Formica integra Mayr	5	-	-
Formica montana Emery	40	-	-
Crematogaster cerasi (Fitch)	3	2	33
Solenopsis molesta (Say)	13	2	124
Tapinoma sessile (Say)	9	2	3
Lasius neoniger Emery	180	247	430
Ponera pennsylvanica Buckley	1	-	4
Leptothorax ambiguus Emery	-	4	13
Stenamma brevicorne Mayr	1	2	10
Formica palledifulva nitidiventrisEmery	1	19	39
Lasius alienus (Foerster)	10	16	-
Polyergus breviceps Emery	2	-	-
Tetramorium caespitum (L.)	48	-	-
Brachymyrmex depilis Emery	1	2	-
Camponotus pennsylvanicus (DeGeer)	-	1	-
Formica pergandei Emery	-	5	3
Lasius flavus (Fab.)	-	6	-
Myrmica americana Weber	-	5	-
Formica sp.	-	-	74
Halictidae (Hb, Hb)			
Undetermined sp.	-	-	1
Ichneumonidae (Hb, Pr)			
Undetermined sp.	-	1	-
Undetermined sp.	-	1	-
Mutillidae (Hb, Pr)			
Undetermined sp.	-	1	-

Myrmaridae (Hb, Pr)			
Undetermined sp.	3	-	-
Undetermined sp.	-	3	3
Undetermined sp.	-	1	-
Pompilidae (Pd, Pd)			
Undetermined sp.	1	-	-
Undetermined sp.	-	1	-
Undetermined sp.	-	-	1
Proctotrupidae (Hb, Pr)			
Undetermined sp.	1	-	-
Pteromalidae (Hb, Pr)			
Undetermined sp.	1	-	-
Undetermined sp.	1	-	-
Undetermined sp.	1	-	-
Undetermined sp.	1	-	-
Undetermined sp.	-	-	1
Scelionidae (Hb, Pr)			
Baeus sp.	1	7	5
Baeus sp.	1	-	2
Duta sp.	1	-	-
Trimorus nr. *pleuralis*	11	-	1
Trimorus nr. *salitarius*	30	-	-
Trimorus nr. *crassellus*	6	-	2
Trimorus sp.	9	5	18
Trimorus sp.	-	-	2
Trimorus sp.	2	2	-
Trimorus sp.	6	-	-
Trimorus sp.	1	-	-
Undetermined sp.	5	-	-
Undetermined sp.	1	-	-
Undetermined sp.	-	2	-
Undetermined sp.	-	-	1
Undetermined sp.	-	-	2
ISOPODA			
Oniscidae (Dt, Dt)			
Armadillidium vulgare (Latreille)	203	68	211
Armadillidium sp.	5	16	-
Trachelipus rathkei Brandt	1	-	1
Undetermined sp.	-	1	-
LEPIDOPTERA			
Cochylidae (Hb, Hb)			
Undetermined sp.	1	-	-
Gelichiidae (Hb, Hb)			
Undetermined sp.	1	-	-

Heliodinidae (Hb, Hb)			
Undetermined sp.	1	-	-
Tortricidae (Hb, Hb)			
Undetermined sp.	1	-	-
LITHOBIOMORPHA			
Lithobiidae (Pd, Pd)			
Lithobius sp.	2	12	12
OPILIONES			
Phalangidae (Pd, Pd)			
Leiobunum sp. or *Opilio* sp.	1	-	8
Phalangium sp.	12	6	5
Undetermined sp.	-	-	7
ORTHOPTERA			
Acrididae (Hb, Hb)			
Undetermined sp.	-	5	1
Gryllacrididae (Dt, Dt)			
Ceuthophilus divergens Scudden	-	-	4
Gryllidae (Om, Om)			
Gryllus pennsylvanicus Burmeister	39	7	4
Nemobius sp.	41	3	29
POLYDESMIDA			
Polydesmidae (Dt, Dt)			
Undetermined sp.	-	-	12
SPIROBOLIDA			
Parajulidae (Dt, Dt)			
Undetermined sp.	3	1	-
THYSANOPTERA			
Phlaeothripidae (Hb, Hb)			
Neothrips(*Bolothrips*)*bicolor* (Heegar)	1	3	-
Undetermined sp.	-	1	-
Thripidae (Hb, Hb)			
Frankliniella tritici (Fitch)	6	4	4
Frankliniella sp.	1	-	-
Frankliniella fusca (Hinds)	-	1	-
Chirothrips manicatus Haliday	2	-	-
Microcephalothrips abdominalis(Crawford)	-	1	-
Undetermined sp.	-	1	-
Undetermined sp.	-	2	-

<u>APPROVAL SHEET</u>

This thesis submitted by Dean G. Stathakis has been read and approved by the following committee:

Dr. Robert W. Hamilton, Director
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The final copies have been examined by the director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the thesis is now given final approval by the Committee with reference to content and form.

The thesis is therefore accepted in partial fulfillment of the requirements for the degree of Master of Science.

4-18-1986
Date

Robert W. Hamilton
Director's Signature